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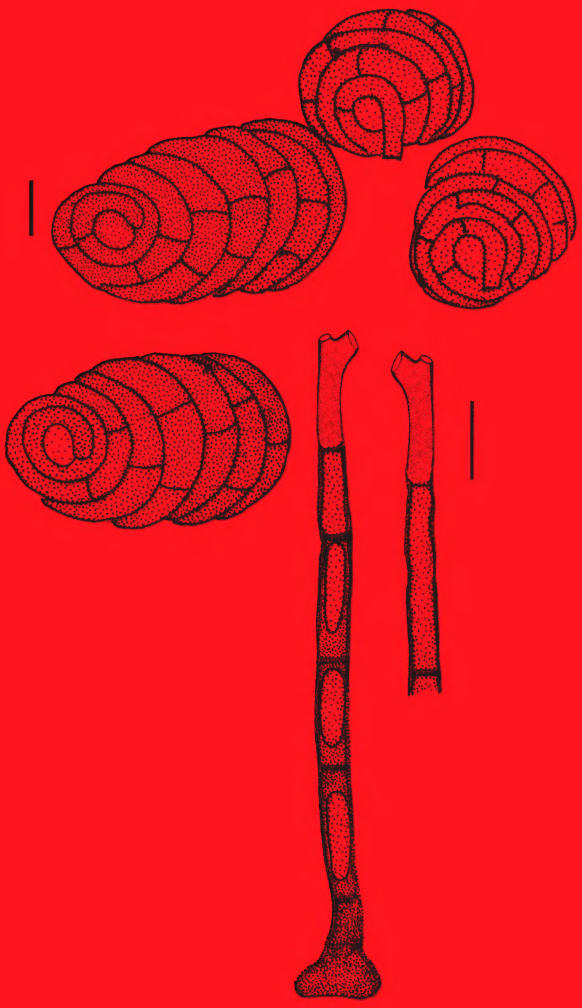

Magnohelicospora iberica gen. & sp. nov.
(Castañeda-Ruiz & al.— FIG. 2, p. 174)
RAFAEL F. CASTAÑEDA-RUIZ, *artist*

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publication date for volume one hundred twenty

MYCOTAXON *for* April–June, volume 120 (i–xii + 1–510)

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Errata from previous volumes

Volume 105

p. 174, line 11	for: *Gloeoporus niger* read: *Gloeoporus dichrous* var. *niger*

Volume 120

p.69, line 37	*for:* with warts or a irregular covering layer of various thickness *read:* with warts or an irregular covering layer of various thickness,
p.70, line 3	*for:* f. Asci with ascospores. g. Conidiophores and conidia. *read:* f. Conidiophores and conidia. g. Asci with ascospores.
p.100, line 21	*for:* Shangri La *read:* Shangri-La
p. 109, line 28	*for:* lichesterinic, protolichesterinic, nephrosteranic, *read:* lichesterinic, protolichesterinic, nephrosterinic,
p. 109, line 31	*for:* except nephrosteranic, *read:* except nephrosteranic,
p. 110, line 18	*for:* the absence of lobaric and fatty acids *read:* the absence of fatty acids
p. 157, line 3	*for:* Akbar Khodaparast *read:* Seyed Akbar Khodaparast
p.199, line 9	*for:* there were recorded *read:* there were three records
p.203, line 3	*for:* Tellería *read:* Telleria
p.257, line 5	*for: Cleistocybe vernalis* Ammirati et al. cluster sister to the *C. acromelalga/C. amoenolens* pair *read: Cleistocybe vernalis* Ammirati et al. clusters sister to the *C. acromelalga/ C. amoenolens* pair
p.264, lines 10–11	*for:* Additionally, our analyses show only a 91% pairwise ITS sequence identity... *read:* Additionally, our analyses show only a 94.4% pairwise ITS sequence identity...
p.289, 4th from bottom	*for:* ...National Natural Science Foundation Program of PR China (31160008, 31060008). *read:* ... National Natural Science Foundation Program of PR China (31160008, 31060008,31260007).
p. 401, line 19	*for:* in July, 2009 is *read:* in July 2009, is

Reviewers — volume one hundred twenty

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers prepared for this volume.

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2—Nomenclatural review: Email text files (with tables & captions but no artwork) to the *Nomenclature Editor* <PennycookS@LandcareResearch.co.nz> for accession and pre-submission review. The Email message *MUST* include 'Mycotaxon' on the subject line and all peer reviewer names+Email addresses in the message. The Nomenclature Editor will assign accession numbers and return annotated files with a list of needed corrections to the authors and *Editor-in-Chief.*

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From the Editor-in-Chief

Melbourne Code published — Authors are urged to consult the new International Code of Nomenclature for algae, fungi, and plants (Melbourne Code) [McNeill et al. 2012]. Fortunately for web-users, the Articles, Notes, and Recommendations are freely available online at <http://www.iapt-taxon.org/nomen/main.php>. Official hard copy may be ordered from Koeltz Scientific Books [Regnum Vegetabile 154. A.R.G. Gantner Verlag KG. ISBN 978-3-87429-425-6].

MycoBank, IndexFungorum & Fungal Name are the 2013 official nomenclatural repositories — The Melbourne Code requires that an identifier issued by a recognized repository be cited in the protologue for valid publication of a new taxon in 2013. MycoBank <http://www.mycobank.org>, established in 2005 as the first fungal nomenclatural repository and now overseen by the International Mycological Association, was joined by Index Fungorum <http://www.indexfungorum.org> in 2009 and Fungal Name <http://fungalinfo.im.ac.cn/fungalname/fungalname.html> in 2010. Mycotaxon initially required a MycoBank identifier seven years ago; recently, however, we have also accepted numbers from IndexFungorum and Fungal Name and will continue to do so.

This past November (2012) representatives from the repositories noted above signed a Memorandum of Cooperation agreeing to work together under the guidance of the Nomenclature Committee for Fungi (NFC). In December the NCF voted by a 71% majority to accept all three registries beginning 1 January 2013, with the NCF recommendation to be ratified by the 2014 Bangkok International Mycological Congress, provided the IMC finds multiple registries workable and effective.

For more information, see Redhead & Norvell (2012; IMA Fungus 3(2): 44–45).

Mycotaxon 121 finally completed! — We greatly regret our very late 'July–September' volume and appreciate even more everyone's patience during the recent difficult period. Although 2012 brought health challenges that both editors would prefer not to have encountered, we are now conquering our manuscript backlog and going forward. Fortunately, the 55 papers in this volume offer Mycotaxon's usual cornucopia of fungal delicacies and insights, and there are at least another 55 fascinating submissions awaiting review for Mycotaxon 122, now scheduled for February.

We take this opportunity to thank our authors and experts for their hard work and to wish everyone health, happiness, peace, progress, and health in 2013. (Health is mentioned twice because we are now convinced it is the most important wish of all!)

Warm regards,

Lorelei Norvell (*Editor-in-Chief*)
1 January 2013

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Agarics of alders 1 – the *Alnicola badia* complex

Pierre-Arthur Moreau[1*], Juliette Rochet[2], Enrico Bizio[3], Laurent Deparis[4], Ursula Peintner[5], Beatrice Senn-Irlet[6], Leho Tedersoo[7] & Monique Gardes[2]

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Abstract — Three closely related species in *Alnicola* sect. *Alnicola*, *Alnicola*, are described, illustrated, and compared. *Alnicola badia* is revised based on the type collection and recent collections made under *Alnus alnobetula*. Two species (*A. longicystis, A. xanthophylla*) associated with *Alnus glutinosa* and *A. incana* and locally frequent in western and central Europe are described as new.

Key words — *Agaricales, Basidiomycota, Hymenogastraceae, Naucoria*, taxonomy

Introduction

The agaric genus *Alnicola* Kühner (*Naucoria s. auct.*) was defined by Kühner (1926) as strictly an *Alnus*-associated genus with small-sized basidiomata and rough basidiospores. Four species were cited by Kühner: three of them (*A. badia*, *A. luteolofibrillosa* and *A. submelinoides*) were new to science, all discovered by Kühner under *Alnus alnobetula* (Ehrh.) K. Koch (Moreau 2005).

This paper is dedicated to the memory of Denise Dailly-Lamoure (26 January 1928 - 26 September 2012), French mycologist, disciple of and successor to Robert Kühner at the University of Lyon.

Although a number of agaricologists studied *Alnicola* species (e.g. Orton 1960, Singer 1978, Reid 1984, Runge 1990, Bon 1992, Ludwig 2000, 2001), each of them presented their own nomenclature and made taxonomy of the genus more and more complex and confusing.

Recent molecular work (Moreau et al. 2006) suggested that species hypotheses in *Alnicola* could be resolved by using several gene sequences to create a robust phylogeny. A four-gene analysis by Rochet et al. (2011) showed that at least 16 phylogenetic *Alnicola* species could be identified in *Alnus*-associated ectomycorrhizal communities in Europe. Most of them could be named according to traditional taxonomy, but some were new to science and given provisional names. Moreover, a complex infrageneric structure of *Alnicola* was suggested in the same study, but no details were given on morphological interpretations of the taxa defined there.

As a first step towards a general taxonomic revision of the genus *Alnicola* in Europe, this article treats the "/badia clade"; a small clade identified by Rochet et al. (2011: fig. 2), which currently encompasses three well-defined species in Europe. Morphological descriptions based on numerous observations of fresh collections and microscopical studies are presented for these three species. One of them, only collected under *Alnus alnobetula* so far, is identified as *Alnicola badia*, the two others, found with *A. incana* and *A. glutinosa,* could not be assigned to any previously described species and are given new names.

Material & methods

Taxonomy and nomenclature

Generic and infrageneric nomenclature follows Moreau (2005). All new names proposed are deposited in MycoBank; holotypes are deposited in herb. LIP (Lille, France), isotypes in herb. IB (Innsbruck, Austria) and ZT (Zürich, Switzerland).

Basidiomata sampling

Basidiomata were collected in Austria (Tirol), France (Alps), Italy (Trentino) and Switzerland (Graubünden). Photographs and morphological descriptions were made from specimens soon after sampling; all specimens were cut and air-dried. Additional collections (exsiccata, notes, and pictures) were provided by collaborators from France and various parts of Europe. Also included are collections of R. Kühner (G); D. Dailly-Lamoure, personal herbarium; M. Moser (IB); U. Peintner (IB); L. Tedersoo (TU); and those in the general herbarium of the Kew Botanical Garden (K). Because intraspecific variability is often important in these species, the following descriptions are based on the holotype; species variability is discussed after each description on the basis of all collections studied.

Descriptions

Morphological descriptions are adapted from notes taken on fresh specimens; colour references (when quoted on fresh material) correspond to Munsell (1975; = M)

Table 1: Basidiospores in representative *Alnicola* collections.

Collection	# spores	L (µm)	W (µm)	Q
A. badia				
04101206	34	(7.2–)7.5–*8.1*–8.7(–9.0)	(4.2–)4.3–*4.8*–5.2(–5.4)	1.58–*1.70*–1.85(–1.93)
07090905	21	(9.6–)10.3–*11.1*–12.0(–12.2)	(5.9–)6.0–*6.7*–7.1(–7.2)	(1.50–)1.55–*1.68*–1.85(–1.91)
09082204	77	(8.4–)8.8–*9.7*–10.3(–10.8)	(5.3–)5.6–*6.1*–6.6(–6.9)	(1.41–)1.47–*1.60*–1.71(–1.93)
A. longicystis				
04092201	30	(9.4–)9.7–*11.1*–11.9(–12.2)	(5.4–)5.5–*6.2*–6.7(–7.0)	(1.57–)1.64–*1.79*–1.94(–2.09)
04092401	40	(9.0–)9.6–*10.9*–12.3(–13.2)	(4.8–)5.4–*5.9*–6.5(–7.0)	(1.58–)1.69–*1.86*–2.10(–2.24)
05082501 *	120	(9.5–)9.9–*10.9*–11.9(–14.5)	(5.6–)5.8–*6.3*–6.8(–8.5)	(1.52–)1.60–*1.74*–1.88(–2.06)
05082501 **	102	(8.3–)8.8–*9.7*–10.6(–12.9)	(4.6–)5.0–*5.5*–5.9(–7.3)	(1.50–)1.64–*1.77*–1.92(–2.10)
A. xanthophylla				
06090101	40	(9.1–)9.5–*10.5*–11.7(–12.0)	(5.6–)5.8–*6.3*–6.8(–6.9)	(1.40–)1.55–*1.68*–1.88(–2.04)
06090104	32	(9.8-)10.5–*12.0*–13.5(–14.0)	(5.4–)5.6–*6.2*–6.8(–7.0)	(1.63–)1.72–*1.94*–2.21(–2.37)
08110901	32	(11.3–)11.6–*12.5*–13.3(–14.6)	(6.0–)6.5–*6.9*–7.4(–7.9)	(1.57–)1.65–*1.81*–2.01(–2.04)
23_7_04	45	(8.8–)9.2–*10.3*–11.7(–11.7)	(5.8–)5.9–*6.4*–6.9(–7.2)	(1.44–)1.47–*1.61*–1.72(–1.84)

Basidiospores measured from spore deposits on stipe in mature, old*, and young** sporocarps; dimensions presented as (minimum value–)1st decile–average value–9th decile(–maximum value). L = Length, W = Width, Q = Quotient (L/W).

or Cailleux & Taylor (1963; = C). Microscopical descriptions are based on observations made at the Laboratory of Botany (Lille), with a light microscope Nachet Andromede 018 at ×100, ×400 and ×1000 magnifications on hand-sectioned mounts in Melzer's reagent, 5% KOH, and Congo red (1 mg in 10 ml NH_4OH) after reviving in 10% KOH for a few minutes. For all collections at least 30 basidiospores have been measured from spore prints or from natural deposits on stipe or pileus surfaces. Statistical treatments and notations follow Fannechère (2005) and measurements were made using the software Mycomètre 2.02 (Fannechère 2011). Estimations of spore dimensions for each collection are given in detail separately in Table 1. In the corresponding description they are re-calculated for all measurements made on collections attributed to the species. In the following descriptions basidiospore dimensions are given as follows: (minimum value–)1st decile–average value–9th decile(–maximum value), and calculated on all basidiospores measured for each species. Pileipellis structures are described and illustrated from radial sections, additional observations on suprapellis structure are made on tangential cuts (scalps). Descriptive terminology for pileus structures s adapted

from Heilmann-Clausen et al. (1997) – proposed for *Lactarius* but perfectly adapted for the description of structures of *Alnicola* and most agaricales. Stipitipellis structures are described from the upper part of stipe, 1-3 mm below the lamellae.

Table 2: Main distinguishing features of *Alnicola badia, A. longicystis,* and *A. xanthophylla.*

Character	*A. badia*	*A. longicystis*	*A. xanthophylla*
Pileus			
Young color	Bicoloured: pale straw ochre margin, date-brown disc	Bicoloured: dirty yellowish margin, dark brown/± olivaceous disc	Uniformly dull yellowish ochre, aging to ± brownish at disc
Striation	Late in age	To centre even when young	Faintly with age
Surface	Minutely scurfy, then glabrous	Smooth, then fibrillose-silky	Furfuraceous, then glabrous, ± cracking
Lamellae	20–30 (1–2), pale gray to pale yellow-ochre	22–24 (2), yellowish ochre	20–26 (2–3), butter yellow
Stipe			
Color	Pale grey ± darker at apex, darkening with age	Purplish black at apex, darkening with age	Dull ochre-yellow, early darkening from base
Apex	± sheathed by caulohymenium, not pruinose	Coarsely floccose	Densely pruinose-floccose
Smell	Weak, resinous, cold tobacco, cedar oil	Fungoid to raphanoid	Strongly raphanoid
Taste	Mild	Mild	Mild, ± astringent
Cheilocystidia	38–50 × 4.5–8 × 2–2.5 µm, neck 9–26 µm long, with yellow walls	45–55 × 6.5–8 × 1.5–2 µm, neck 18–38 µm long, partly with yellow walls	28–36 × 8–9.5 × 2 µm, neck 10–15 µm long, with bright yellow walls
Pleurocystidia	Scattered towards edge	Abundant towards edge	Scattered towards edge
Caulocystidia	Scattered at apex, intermixed with clavate elements	Abundant at apex	In dense clusters at apex, intermixed with clavate-catenulate elements
Pileipellis			
Morphology	Oedotrichoderm	Hyphoepithelium	Hyphoepithelium
Subpellis	40–50 µm thick	35–50 µm thick	50–70 µm thick
Hyphal pigments	Smooth to punctuate	Smooth	Incrusted in subpellis, smooth in suprapellis
Basidiospores	7.5–10.5 × 4.6–6.5 µm Ovo-amygdaliform not papillate	8.8–12.3 × 5.5–6.8 µm Amygdaliform partly subpapillate	9.2–13.5 × 5.6–7.4 µm Amygdaliform ± elongated, not papillate
Alnus host; substrate	*A. alnobetula*, mainly on mineral soil	*A. glutinosa, A. incana*, on humus-rich or acidic soil	*A. glutinosa, A. incana*, mainly on bare, ± mineral soil

Taxonomy

Alnicola badia Kühner, Botaniste 17: 176. 1926. FIGS 1–2

≡ *Naucoria phaea* Maire & Kühner, in Maire, Bull. Inst. Bot. Barcelona 3(4): 101. 1937.

≡ *Alnicola phaea* (Maire & Kühner) Romagn., Bull. Soc. Mycol. France 58: 126. 1942, nom. superfl.

?= *Naucoria cedriolens* Bresinsky & Schmid-Heckel, in Schmid-Heckel, Forschungsber. Nationalpark Berchtesgaden 8: 163. 1985.

≡ *Alnicola cedriolens* (Bresinsky & Schmid-Heckel) Bon, Doc. Mycol. 21(83): 37. 1991.

"*Alnicola phaeodisca* Kühner in sched. [R. Kühner, unpublished notes, (G)].

ILLUSTRATED REFERENCE — Moreau et al. (2011: 33).

DESCRIPTION OF HOLOTYPE (adapted from handwritten notes of R. Kühner on the holotype n° 9.100, G) — "Pileus 1.5–2.5 cm, convex-flat ± umbonate, opaque or hardly striolate on one specimen, reddish bistre (margin paler), under whitish pruinose flakes (furfuraceous aspect), then red-brown and pruinose, hygrophanous. Taste mild, odour none. Lamellae 22–23 at stipe, 3–7 lamellules per lamella, almost spaced, cinnamon brownish. Stipe 3.5–4.5 × 0.17–0.25 cm, equal, flexuose, base ± coated with a white cotton-like mycelium; fulvous-brown, glabrescent, slightly pale-fibrillose, with slightly fluffy or minutely pruinose apex, narrowly fistulose; context brown. Spore amygdaliform, 9.5–10.0 × 5.5 (10.5 × 6.0) µm, faintly rugose-punctate, cheilocystidia cuspidate. Cellular cuticle distinctly deviating.[1] Trama regular, made of short hyphae. Basidia 4-spored, 28–29 × 8–9 µm; paraphyses shorter, cylindro-clavate. Subhymenium narrow, cellular-branched."

DESCRIPTION OF RECENT COLLECTIONS — Pileus 0.8–2.5(–3) cm, early flattened without distinct umbo or lowly convex-flattened, completely scurfy-squamulose at first with pale ochre to whitish squamules, especially towards margin, becoming glabrous towards centre by erosion, never cracked; distinctly bicoloured at first: margin pale straw-ochre (2.5YR2/4, M), centre date brown to dark red-brown (2.5YR5/6), not or hardly striate (only when old and wet), hygrophanous, quickly fading from disc to yellowish ochre slightly darker at centre. Lamellae crowded, 20–30 reaching stipe, 1–2 series of lamellulae, narrow, adnate-subdecurrent to ± emarginate, pale grey-ochre to slightly yellowish ochre, when mature cinnamon ochre (7.5YR6/4, M); edge white pruinose. Stipe 2.5–6(–9) × 0.1–0.2 cm, not pruinose at apex, somewhat sheathed by caulohymenium under lamellae, fibrillose-twisted below, pale greyish, on some collections slightly darker gray at apex, then greying, blackish brown at the

[1]Kühner frequently used this term for describing pileus structures in naucorioid groups (Kühner 1931, 1942, 1980). A "deviating" structure refers to a basically hymenodermioid structure, more or less "degraded", i.e. with inflate terminal cells of more or less radial orientation and adpressed (transitions to hyphotrichoderm).

base, with white ± strigose mycelium. Smell weak, ± resin-like, reminding of cedar oil, cooking oil or cold tobacco; taste mild, insipid to weakly fungoid-raphanoid.

Pileipellis an oedotrichoderm (Heilmann-Clausen et al. 2007) 60–90 µm thick; suprapellis made of 3-5 layers of hyphae, each a long chain of up to 15 catenulate cells, more or less fasciculate and erected, prostrate with age, cells cylindrical to inflate, subterminal cells often constricted, 9-20 µm wide, usually of thin- (<0.2 µm thick) yellowish walls, but some (about 10%) with thicker yellow to brownish walls or thickened only at septa, smooth to locally encrusted; terminal cells frequent, cylindrical to fusiform, 45–70 × 7–15 µm, smooth and thick-walled; rarely with superficial very slender hyphae 2–2.5 µm wide, observed on surface (scalp, sections) with yellow thickened wall and coarsely incrusting yellow pigment; subpellis hardly differentiated from suprapellis, 40–50 µm thick, made of 4–6 layers of short cylindrical to polygonal cells 7–15 µm wide, with yellow walls up to 0.5 µm thick, minutely punctuate to locally distinctly incrusted, not stained by KOH. Pileus trama pale, with somewhat brownish zones, composed of variously shaped hyphae, slender cylindrical hyphae 3–5 µm wide, and cylindrical to ampullaceous hyphae 8–25 µm wide, mostly smooth, some incrusted or with light yellow walls especially at septa. Stipitipellis with sparse clusters of caulocystidia at apex, 45–90 × 6–14 µm, some repent, cylindro-clavate more or less curved, with or without lateral neck, mixed with more typical ampullo-fusiform cystidia, all with yellow thickened walls. Superficial hyphae 4-6 µm wide, wall yellow and coarsely incrusted. Stipe context composed of cylindrical hyphae 5–14 µm wide, with smooth strongly thickened walls up to 1.5 µm thick, yellowish towards cortex, paler in centre.

Basidiospores (5 collections, 196 measurements) (6.7–)7.5–*9.02*–10.5 (–12.2) × (4.2–)4.6–*5.48*–6.5(–7.2) µm, Q = 1.51–*1.65*–1.79, ovoid to slightly amygdaliform with obtuse apex, never subpapillate, ochre-yellow in KOH, not dextrinoid, uniguttulate in KOH, ornamentation of low warts less than 0.2 µm long, punctiform-rounded, not confluent, weakly contrasted; episporium not distinct. Basidia 22–26(–32) × 6.5–8 µm, cylindro-clavate, 4-spored, base variously elongated, before maturity with granular content, sometimes weakly brownish; necrobasidia abundant, deep ochre yellow in KOH. Subhymenium 12–15 µm thick, ramose with short cylindrical articles 3–4.5 µm wide, hyaline. Hymenial trama regular, mediostratum almost colourless to pale brownish zoned, made of short cylindrical hyphae 15–45 × 4–14 µm, with yellowish wall locally thickened (up to 1 µm thick) and incrusted. Lamella edge sterile; cheilocystidia 38–50 × 4.5–8 µm (base), × 2–2.5 µm (apex), ampullaceous at base, with distinct attenuate neck 9-26 µm long, sometimes obtuse to ± inflate at apex (e.g. on holotype, Fig. 1), all with thickened yellowish wall up to 0.5 µm thick, most colourless, scattered ones with deep yellow content. Pleurocystidia

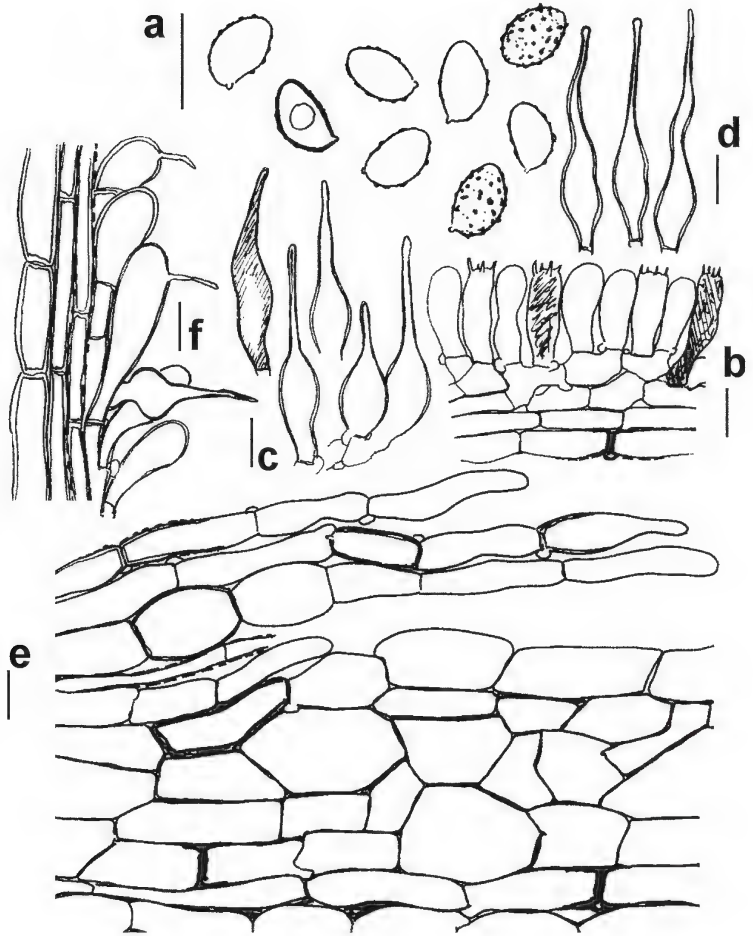

FIGURE 1: *Alnicola badia* (09082204, LIP). a: basidiospores; b: portion of hymenium with basidia and subhymenium; c: cheilocystidia; d: pleurocystidia; e: pileipellis, radial section; b: stipitipellis at stipe apex (longitudinal section.). Scale bar = 10 µm.

scattered but not unfrequent towards edge, much rarer 300 µm in from the edge, 36–56 × 6–6.5 µm (base), × 2 µm (neck), fusiform, neck 22–40 µm long and attenuate, occasionally abruptly inflated at apex, walls thickened and yellowish up to 0.3 µm thick, originating from deep in subhymenium. Gloeoplerous hyphae absent to very rare, pale yellow, slender, cylindrical, in stipe and pileus context. Clamp connections present at all septa.

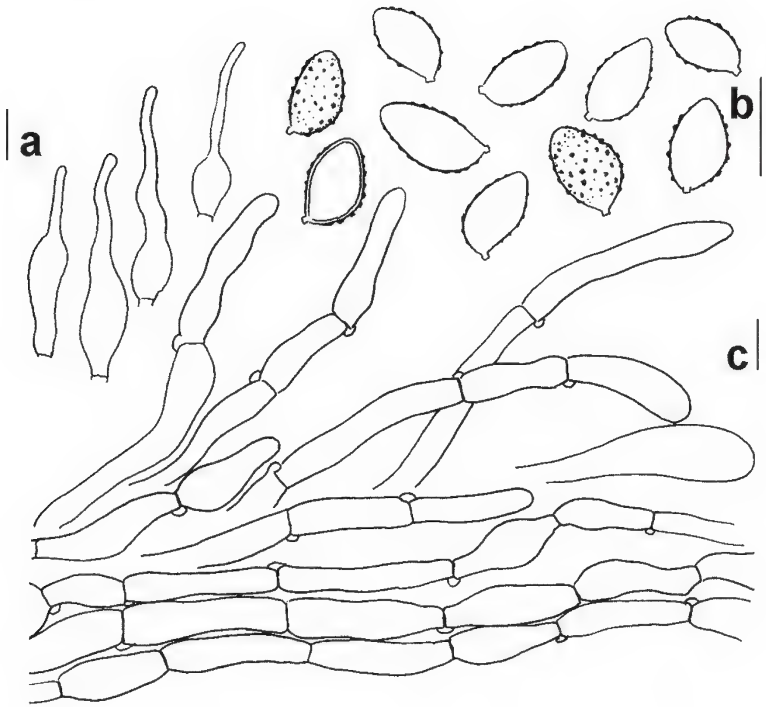

FIGURE 2: *Alnicola badia* (Holotype, R. Kühner 9.100, G). a: basidiospores; b: cheilocystidia; c: pileipellis, radial section. Scale bar = 10 µm.

SPECIMENS EXAMINED — **AUSTRIA**, **TIROL**, Obergurgl, *Alnus alnobetula*, 25 August 2005, P.-A. Moreau n° 05082717 (LIP); 28 August 2005, P.-A. Moreau 05082808b (LIP). **FRANCE**, **CORSE DU SUD**, Bocca Palmente, *Alnus alnobetula* subsp. *suaveolens* along a stream, leg. F. Richard & P.-A. Moreau, 12 October 2004, P.-A. Moreau 04101209 and 04101206 (LIP); Bastelica, val d'Ese, *Alnus alnobetula* subsp. *suaveolens* in sand along a stream, 7 September 2007, P.-A. Moreau 07090822 (LIP); 8 September 2007, P.-A. Moreau 07090905 (LIP); 3 September 2008, P.-A. Moreau 08090340 (LIP; illustrated in Moreau et al. 2011: 33); **HAUTE-CORSE**, Vizzavona, Monte d'Oro, under *Alnus alnobetula* subsp. *suaveolens* along a stream, leg. F. Richard & P.-A. Moreau, 11 October 2004, P.-A. Moreau 04101101 (LIP); **HAUTE-SAVOIE**, Samoëns, Collet d'Anterne, 6 September 1958, R. Kühner Sa-58-58 (G, "*Naucoria subescharoides*" in herb., "*Alnicola phaeodisca*" in sched.); **SAVOIE**, La Perrière, Praz Joseph, 31 August [see note 1], under alders on ground, R. Kühner 9.100 (G, **holotype**); la Rosière, left side of the road to La Jairaz below the dam, under *Alnus alnobetula*, 8 September 1942, R. Kühner (G, "*Naucoria* (*Alnicola*) Joniss A"); under La Rosière, 10 September 1942, under *Alnus alnobetula*, R. Kühner (G, "*Alnicola* [*Nauc. pannosa* ?] Joniss A"); above La Rosière, *Alnus alnobetula*, 18 September 1961, R. Kühner (G, "sp.1961"); Bourg-Saint-Maurice, Arc 1800, above the golf area, in old *Alnus alnobetula* thickets along a stream on acidic soil, 1870 m, 7 September 1993,

P.-A. Moreau n° 93090702 (LIP); ruisseau du Villard, 19 August 2002, J.-C. Deïana, P.-A. Moreau JCD19-8-02; 21 August 2003, P.-A. Moreau 03082102 (LIP); Peisey-Nancroix, Nancroix, les Lanches, under *Alnus alnobetula*, calcareous watercourse, P. Saviuc, 21 October 2003, P.-A. Moreau 03082110 (LIP); Landry, Barmont, under *Alnus alnobetula*, leg. M. Broussal, 23 August 2003, P.-A. Moreau 03082301 (LIP); 26 October 2007, P.-A. Moreau 07082637 (LIP); Bessans, Ecot de Bonneval, under *Alnus alnobetula*, 1 October 2008, leg. M. Durand, M. Durand 08100119 and 08100121 (LIP); Crest-Voland, APPB Tourbière des Saisies, along the Nant Pareu stream, acidic peaty soil under *Alnus alnobetula* subsp. *alnobetula* amongst liverworts (*Pellia* spp.), 22 October 2009, P.-A. Moreau 09082204 (LIP); Beaufort, Cormet d'Arèches above the Lac des Fées, under *Alnus alnobetula* on calciferous schists, 22 October 2008, P.-A. Moreau 08082201 (LIP); leg. C. Hugouvieux, 27 October 2009, P.-A. Moreau 09082703 (LIP); locality unknown (Savoie or Haute-Savoie), 1964, R. Kühner n° 64-20 (G). **SWITZERLAND, Graubünden**, Davos, leg. H. Gamper, under *Alnus alnobetula* isolated bush in a pasture, 1 August 2003, P.-A. Moreau 03080101 (LIP); Bergün, above the Palpuogna lake, under *Alnus alnobetula* on acidic ground along a stream, 14 August 2003, P.-A. Moreau 03081403 (LIP); 2 September 2006, P.-A. Moreau 06090202 (LIP); Lenzerheide, Parpan, under a thicket of *Alnus alnobetula*, 31 August 2006, P.-A. Moreau 06083102 (LIP).

Note 1 — The year of collection of the holotype is neither mentioned in the notes nor in any of Kühner's publications, but the notes (kind of paper, handwritten indications and style) are identical to those on *A. submelinoides* and *A. luteolofibrillosa*. The collection of *A. submelinoides* was dated 1924 by Kühner (1931) himself, therefore 31 August 1924 should be accepted as the date of collection of the original material of *A. badia*.

GenBank accession numbers (Moreau et al. 2006, Rochet et al. 2011) — **ITS1-5.8S-ITS2**: AY900031, AY900032, AY900033, AY900036, AY900037, AY900039, HQ714656, HQ714657, HQ714658, HQ714664, HQ714670, HQ714676, HQ714755, HQ714756, HQ714781, HQ714787. **GPD**: HQ714896, HQ714597, HQ714598, HQ714599, HQ714603, HQ714608, HQ714614. **RPB2**: HQ714796, HQ714797, HQ714799, HQ714800, HQ714811, HQ714818. **V9**: HQ714500, HQ714508.

Ecology and distribution — Only known with *Alnus alnobetula*, usually on acidic substrate, on wet humus amongst liverworts, more rarely on schists; known from subalpine altitudes of Western and Central Alps (Austria, France, Switzerland) and Corsica. Widespread but usually not abundant, often scattered.

Observations — Kühner (1926, 1931) found his very first collections of *A. badia* and *A. submelinoides* (a species with club-shaped cystidia) together in 1924 at the same locality of Praz Joseph, La Perrière (near Bozel, Savoie). In fact both species often grow together and are easy to mistake in the field. Dry *A. badia* can be detected by darker colours, and especially blackish stipe on mature specimens, while dry basidiomata of *A. submelinoides* remain pale.

It cannot be proved that Heim's (1931) representation of the pileipellis of *A. badia* was based on Kühner's holotype, but we are inclined to think so because: 1) Kühner contributed to Heim's work; 2) Heim does not seem to have collected any agaric himself under *Alnus alnobetula* in the Alps; 3) pileus

structure excludes all species known to us from lowland species of *Alnus*; and 4) at this date Kühner only knew *A. badia* from his type collection. However Heim's figure is a representative – although somewhat stylized – illustration of the oedotrichodermial structure observed on our typical collections of *A. badia*; it is reproduced by Clémençon (1997: 58, fig. 2.61) who interprets it as "moniliform physalohyphae".

Variability of the species —The pileus colour of *A. badia* is variable, making identification uncertain in the field. Also, basidiomata are often scattered, intermixed with other species, and young and old specimens can be easily confused with other species without microscopic observations. However, a pale pileus margin with light ochre tones, distinctly bicoloured on darker specimens, and pale browning stipe are apparently constant features distinguishing it from other *Alnicola* species found with *Alnus alnobetula*. The presence of pleurocystidia is usually confined to the vicinity of lamella edge, and sometimes not conspicuous (very scarce on PAM07090905). A spectacular variation is found in spore size within the same otherwise homogenous collection (see Table 1), ranging from rather narrow (3.8–4.8 µm wide in average) to widely ovo-amygdaliform (6.0–6.6 µm wide in average), partly attributed to age of specimens; but they are rather well characterized by low, thin punctuate ornamentation and obtuse, neither attenuate nor mucronate apex.

Extralimital collections — 1) A few collections from mineral substrates in Corsica (riverbed) and Savoy (calciferous schists) show a more distinct cedar-like smell; such collections are described in the diagnosis of *A. cedriolens* (Schmid-Heckel 1985). There is no morphological or molecular evidence that this character supports a distinct taxon. The same cedroid smell has also been reported on collections of *A. luteolofibrillosa* (Moreau 2005; E. Campo, pers. com.); 2) two rather poor collections also from Savoy and Corsica are morphologically conform to *A. badia* but have a slight aromatic smell reminiscent of *Inocybe bongardii* (Weinm.) Quél. (or *Alnicola suavis* (Bres.) Kühner); basidiospores are at the larger size limit for *A. badia* (suggesting senescent or damaged specimens) and no sequence could be generated for these collections.

Alnicola longicystis P.-A. Moreau, Bizio & Deparis, **sp. nov.** Fig. 3

MycoBank MB 563643

Similar to *Alnicola badia* and *A. xanthophylla* by cheilocystidia with yellow thickened walls, amygdaliform punctate basidiospores, pleurocystidia, and mild taste. Diagnosed by purplish-black stipe apex when young. Differs from *Alnicola badia* by association with *Alnus glutinosa* and *A. incana*, pileus striate from early stages, and frequent pleurocystidia.

Type: Italy, Trentino, Balsega di Pinè, Alnus incana, 25.VIII.2005, leg. A. Aiardi & E. Bizio, herb. P.-A. Moreau n° 05082501 (**Holotype**, LIP; **isotypes,** IB 20050690, ZT).

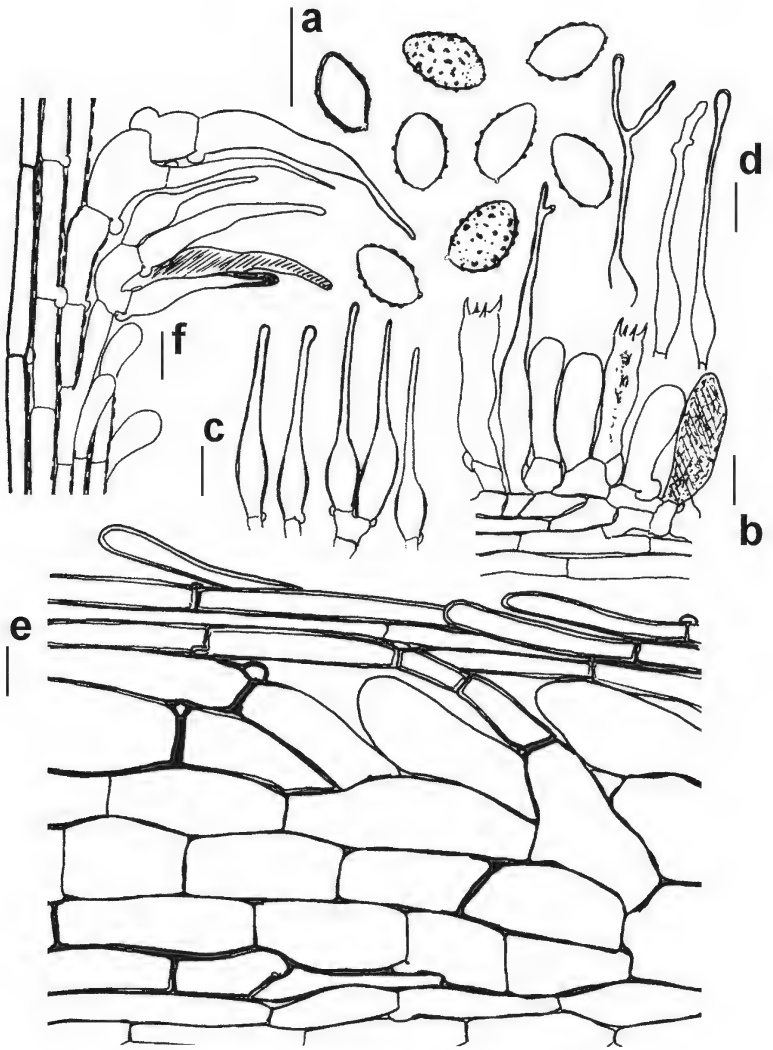

FIGURE 3: *Alnicola longicystis* (Holotype, 05082501, LIP). a: basidiospores; b: portion of hymenium with basidia, pleurocystidia and subhymenium; c: cheilocystidia; d: pleurocystidia; e: pileipellis, radial section; e: stipitipellis at stipe apex, longitudinal section. Scale bar = 10 µm.

ETYMOLOGY: "with long cystidia", referring to the distinctive lanceolate cheilocystidia with elongated neck.

Pileus 0.8–2.5 cm, convex then soon flattened, striate to centre, at first pale yellowish ochre with subpapillate dark brown centre, this dark colour expanding

with age, when old gradually brownish-grey at centre with somewhat olivaceous tones (H63-H64, C) to dirty yellowish at margin (B72), hygrophanous, fading uniformly to pale ochraceous (A84), when fresh almost glabrous and smooth, becoming fibrillose-silky from margin when drying. Lamellae crowded, 22–24 reaching the stipe, 2 series of lamellulae, adnexed-horizontal to slightly emarginated, at first yellowish ochre to pale lemon-ochre (A84), darkening slightly with age to dull ochre (C74-D74), rusty ochre when old; edge white, minutely pruinose. Stipe 3–8 × 0.1–0.3 cm, fistulose, slightly enlarged at base, initially dull ochre brown with purplish-black apex, coarsely floccose at apex, below whitish-fibrillose, fading to pale yellowish in lower part with age, apex remaining darker, base darkening on older specimens. Context greyish in pileus, dark grey-brown at apex, yellowish in stipe cortex. Smell strongly fungoid or raphanoid. Taste raphanoid or fungoid, mild.

Basidiospores (3 collections, 292 measurements): 8.8–*10.48*–12.3 × 5.5–*5.97*–6.8 µm, Q = 1.60–*1.79*–2.10, amygdaliform, dimorphic with a variable proportion of large basidiospores with more elongate to subpapillate apex, rather bright yellow in KOH, not dextrinoid, ornamentation when mature warty-punctate to echinulate, up to 0.3 µm high, warts isolated, irregular in size but rarely confluent, before maturity often as low patches (especially when observed on hymenium); content homogenous, not distinctly guttulate, or with a single irregular drop; episporium not loosening. Basidia all with 4 sterigmata, strongly heteromorphic: 21–36 × 6.5–8.5 µm, cylindrical, slightly strangulate under apex when mature, with variously elongated base, the longest generating larger basidiospores; necrobasidia with yellowish brown content frequent, collapsed, but also some basidioles and young basidia with yellow cytoplasmic content present, otherwise colourless; most mature basidia with dense colourless granular content. Subhymenium compact and weakly developed, 10–12 µm wide, composed of small short cells forming a thin pseudoparenchymatic tissue. Mediostratum of lamellae regular, pale yellow-brown in KOH, composed of slender and wide hyphae intermixed, 3–14 µm wide, with smooth slightly thickened walls. Lamella edge sterile; cheilocystidia (38–)45–55 × 6.5–8 µm (base), × 1.5–2 µm (neck), all lanceolate with an exceptionally long and slender neck (18–38 µm long), slightly thick-walled (up to 0.3 µm thick), some with the neck filled with yellow pigment towards apex; often with small basidioles intermixed. Pleurocystidia relatively frequent up to 200 µm from the lamella edge, larger and slenderer than cheilocystidia, 55–62 × 5.5 µm (base), × 1.5–2.5 µm (neck), with a long neck often difformed: capitate, inflated, ramose or bifid, often yellow at apex, arising distinctly from hymenium, disappearing early from edge to sinus.

Pileipellis a thick hyphoepithelium (Heilmann-Clausen et al., 2007); suprapellis 12–20 µm thick, distinctly yellowish coloured, made of 2–4 layers

of cylindrical-filamentous hyphae 2.5–7 µm wide, walls yellow, up to 0.5(–1) µm thick, smooth; terminal cells cylindrical with rounded to slightly inflated apex. Subpellis 35–50 µm thick, very distinct, formed of inflated to subglobose cells 25–75 × 6–28 µm, with pale yellow smooth walls, moderately thick-walled except towards septa (up to 1 m thick). Pileus trama of short, pale and smooth walled hyphae, 3–8 µm wide. Stipitipellis covered by a velipellis of cylindrical, incrusted hyphae 5–6.5 µm diam, with scattered erected clavate cells; at apex intermixed with large clusters of caulocystidia 40–70 × 5.5–11 µm, lanceolate with long neck, most with yellow apex, some collapsed with yellow-brown necropigment. Stipe trama made of parallel hyphae, 3–12 µm diam, with yellowish slightly incrusted wall, often thickened and more brownish at septa; gloeoplerous hyphae very rare, long, sinuous and slender (3–4 µm diam.), with yellow-brown thick walls in KOH. Clamp connections present at all septa.

Additional specimens examined — **ESTONIA**, **Viliandi**, Songa, 58°18′N 25°22′E, *Alnus glutinosa*, 12 September 2009, L. Tedersoo 110256 and 110257 (TU); **Lääne**, Vormsi, Fällarna, 59.001°N 23.202°E, *A. glutinosa,* 17 September 2010, L. Tedersoo 110285 (TU); Hullo, 59.008°N 23.2275°E, *A. glutinosa*, 17 September 2010, L. Tedersoo 110300 (TU); Söderby, 59.0049°N 23.3520°E, 18 September 2010, L. Tedersoo 110304 (TU); **Põlva**, Järvselja ürgkvartal, 58°16′N 27°19′E, *A. glutinosa*, 30 September 2010, L. Tedersoo 110343 (TU); **Tartu**, Haage, 58.363°N 26.63°E, 26 September 2010, L. Tedersoo 110321 (TU); Maksa, 58°22′N 27°03′E, *A. incana*, 30 September 2010, L. Tedersoo 110344 (TU); Porijõe, 58°23′N 26°43′E, *A. incana*, 6 October 2010, L. Tedersoo 110358 (TU). **FRANCE**, **Haute-Savoie**, les Houches, under *A. incana* and *A. alnobetula* intermixed, 22 September 2004, P.-A. Moreau 04092201 (LIP); Argentière, under *A. incana* on acidic peaty ground, 24 September 2004, leg. L. Deparis & P.-A. Moreau, P.-A. Moreau 04092401 (LIP); **Landes**, Yrieu, edge of brook with *A. glutinosa*, 29 avril 2000, leg. J. Guinberteau & P.-A. Moreau, P.-A. Moreau 100 and 101 (LIP); **Pas-de-Calais**, Boulogne-sur-Mer, domanial forest, oceanic deciduous forest on clay soil, under *A. glutinosa* along a rivulet, 10 September 2009, P.-A. Moreau 09091001 (LIP); **Savoie**, Séez, along the Isère river, under *A. incana* in a mixed riparian forest, leg. M. Gardes, J. Rochet & P.-A. Moreau, 28 August 2008, P.-A. Moreau 08082805 (LIP); Bozel, les Perrières, under *A. incana* along a rivulet in a *Fagus* forest, 780 m, 26 August 2010, P.-A. Moreau 10082611 (LIP); Beaufort, Arèches, le Perthuis, wet mesotropic riparian forest with *A. incana*, 22 August 2011, P.-A. Moreau 11082203 (LIP). **SPAIN**, **Cantabria**, Ruente, Parque natural, under *A. glutinosa* on acidic peaty soil, 29 October 2011, P.-A. Moreau 11102901 (LIP).

GenBank accession numbers (Moreau et al. 2006, Rochet et al. 2011, Tedersoo et al. 2009) — **ITS1-5.8S-ITS2**: AY900038, AY900075, FM993128, FM993140, FM993256, FM993273, HQ714667, HQ714757, HQ714795, HQ714668: **holotype**; **GPD**: HQ714605, HQ714606: **holotype**, HQ714641; **RPB2**: HQ714808, HQ714809: **holotype**, HQ714885; **V9**: HQ714576: **holotype**.

Ecology and distribution— With *Alnus glutinosa* and *A. incana*, most often on humus-rich substrates, typically in wet mixed *Alnus–Corylus* thickets on acidic ground (often with *Polytrichum* or *Sphagnum* spp.), but also in neutrophilic to slightly basophilic river sides with *A. xanthophylla*, known from

lowland to mountainous altitudes (1000 m); known from siliceous mountains of Western and Southern Europe (Pyrenees, Cantabrian Mountains, Alps; also isolated from mycorrhizae in Corsica, unpublished data) and scattered localities in coastal forests (Aquitaine, North of France), as well as Estonia. Probably widespread in Europe, gregarious but rarely abundant.

Observations — This is one of the most frequent species of *Alnicola* associated with *Alnus incana* in the mountains. It is found on river sides (with *Gyrodon lividus* and *Paxillus filamentosus*) as well as in acidic peaty alder stands amongst *Sphagnum*. It is also present but rare and scattered in coastal peaty forests under *Alnus glutinosa*. In alpine regions it can be found together with *Alnicola xanthophylla*, which differs macroscopically on the field by distinctly striate pileus, yellow lamellae, and the absence of purplish black spot at stipe apex. Because colours evolve strongly with age, old or atypical specimens can be difficult to interpret in the field, but can be recognized easily by long-necked cheilocystidia and pleurocystidia (e.g., most cheilocystidia measuring 45–55 × 6.5–8 µm in *A. longicystis*, 28–36 × 8–9.5 in *A. xanthophylla*). *Alnicola badia*, which can show the same characteristic dark tones at stipe apex, differing especially by the host tree and a pileus becoming striate only with age. *Alnicola umbrina* (Maire) Kühner (Kühner 1931: 241) differs by more foxy to brown colours and the fusiform spores and cystidia (Moreau 2005).

Alnicola xanthophylla P.-A. Moreau, Peintner & Senn-Irlet, **sp. nov.** Fig 4

MycoBank MB 563644

Differs from *Alnicola longicystis* by a pileus that is striate only in age, uniform yellowish colors, and shorter cheilocystidia with bright yellow walls and necks ≤ 15 µm long.

Type: SWITZERLAND, Graubünden, Rothenbrunnen, leg. P.-A. Moreau & B. Senn-Irlet, 1.IX.2006, herb. P.-A. Moreau 06090101 (**Holotype**, LIP; **isotypes**, IB20060540, ZT).

Etymology: "with yellow gills", referring to the characteristic butter-yellow tinges of lamellae.

Pileus 1–2.5 cm diam, soon flattened to slightly obtuse, slightly striate when mature, entirely furfuraceous, glabrescent, often cracked-squamulose when old, dull yellowish ochre (C74-C66, C), subpapillate, brownish at centre, gradually pale yellowish towards margin, when old dark grey, strongly hygrophanous fading to uniformly dull greyish ochre to somewhat more rusty at centre (C72 or a bit darker), slightly fibrillose under a lens, without trace of veil. Lamellae very crowded, 20–26 reaching the stipe, 2(–3) series of lamellulae, adnexed to almost free, initially butter yellow (D68-C68), becoming dull greyish ochre when old, at the end tobacco brown; edge pale yellow, smooth to pruinose-pubescent. Stipe 2–5 × 0.1–0.2 cm, equal or slightly enlarged at base, when very young dark grey-brown at apex, then uniformly dull ochre-yellow (C74),

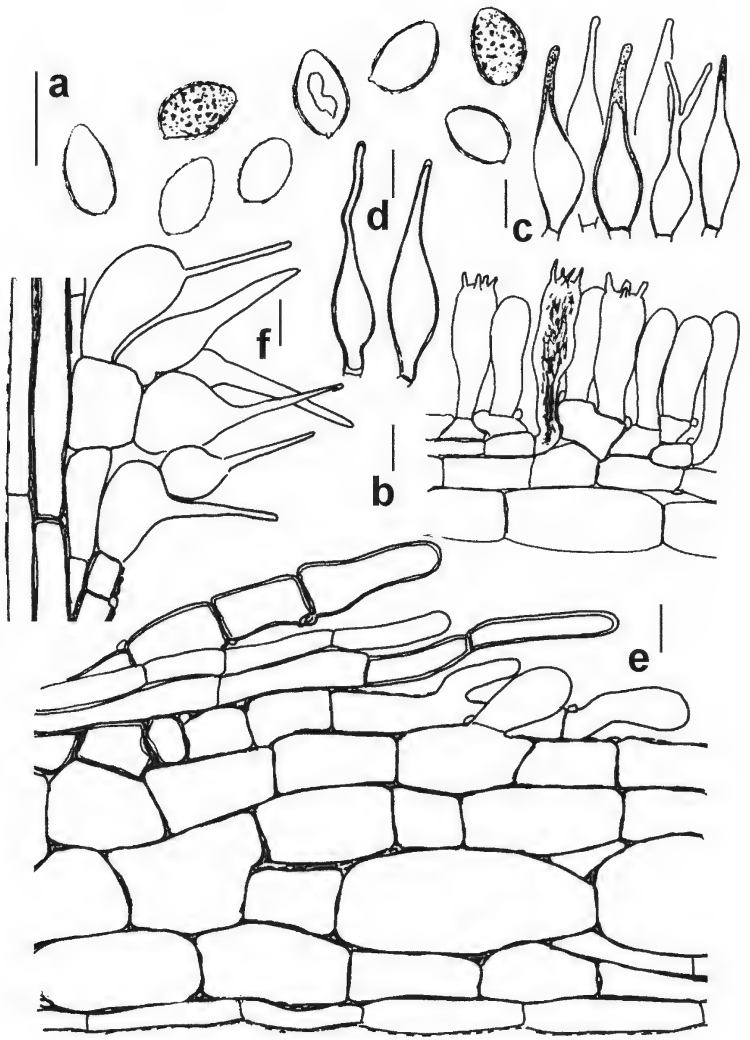

FIGURE 4: *Alnicola xanthophylla* (Holotype, 06090101, LIP). a: basidiospores; b: portion of hymenium with basidia and subhymenium; c: cheilocystidia; d: pleurocystidia; e: pileipellis, radial section; f: stipitipellis at stipe apex, longitudinal section. Scale bar = 10 µm.

soon browning from base, at maturity dark grey-brown with yellowish tones at apex, densely pruinose-floccose 2–3 mm under the lamellae, slightly covered

by fibrils more conspicuous on old darkened specimens, without trace of veil; mycelium white hardly visible. Context grey when fresh then whitish, amber-yellow in cortex, when old dirty grey in stipe base. Smell strongly raphanoid. Taste mild, raphanoid, more or less astringent.

Basidiospores (4 collections, 149 measurements): 9.2–*11.20*–13.5 × 5.6–*6.46*–7.4 µm, Q = 1.55–*1.76*–2.21, ovo-amygdaliform, rather polymorphic and partly elongated with acute apex but not distinctly subpapillate (a majority of abnormally elongate basidiospores on coll. PAM06090104), bright yellow in KOH, not dextrinoid, ornamentation when mature warty-punctate, up to 0.3 µm high, warts low and obtuse, irregular in size, punctiform to slightly cristate; content with a large irregular droplet and often granular cytoplasm; episporium not or only slightly loosening. Basidia all with 4 sterigmata, cylindro-clavate with more or less elongate base, 22–32 × 7.5–9.5 µm; necrobasidia abundant, with amber-yellow content, usually collapsed, young and mature basidia usually colourless. Subhymenium thin, filamentous, 5–8 µm, made of slender hyphae 2–4 µm wide, with small, short cells forming a weakly developed pseudoparenchymatic structure. Lamella mediostratum regular, 80–100 µm wide, pale to almost colourless in KOH, made of shortly cylindrical to polygonal or strongly inflated cells 7–35 µm wide, pale yellow, with smooth, slightly thickened walls. Lamella edge sterile; cheilocystidia 28–36(–40) × 8–9.5 µm (base), × 2 µm (neck), shortly fusi-lageniform with strongly inflated base and rather short attenuate neck (10–15 µm long), apex obtuse to slightly rounded, walls bright yellow, especially thickened, up to 0.5 µm at apex, without basidia found intermixed. Pleurocystidia scattered, only frequent very close to the edge but sometimes up to 200–300 µm from the edge, 32–40 × 6–8 µm (base), × 2 µm (neck), fusiform with longer neck than cheilocystidia (15 µm long), sometimes tortuous, bright yellow, arising from subhymenium, disappearing towards sinus.

Pileipellis a hyphoepithelium; suprapellis 20–30 µm thick made of 1–2(–3) layers of cylindrical to catenulate hyphae of cells 18–45 × 4.5–11(–16) µm, ± erected towards centre, terminal cells cylindrical-attenuate; walls yellowish to brownish on some cells, smooth; subpellis 50–70 µm thick, very distinct, reddish ochre in KOH, cellular, with slightly radial-ascendant orientation, made of cylindrical to polygonal or subglobose isodiametric cells, 15–90 × 8–30 µm, with yellow incrusted walls, especially thickened and brownish at septa. Pileus trama reddish brown in KOH, under subpellis gradually paler, composed of cylindrical hyphae 4–16 µm wide, more inflated towards surface, walls minutely incrusted. Stipitipellis at apex with sparse short catenulate hyphae 5–8 µm wide, dark yellowish, with thickened strongly incrusted walls, intermixed towards apex with dense clusters of caulocystidia 22–28 × 10–18 µm (base) × 2–2.5 µm (neck), strongly inflated with attenuate neck 12-25 µm

long, only slightly thick-walled (some with thickened yellow neck). Stipe trama made of parallel hyphae, 3–12 µm wide, with yellowish incrusted walls in cortex, colourless in depth; gloeoplerous hyphae sparse, more frequent towards base, short and rather wide (5–8 µm), dark reddish brown in KOH. Clamp connections present at all septa.

Additional specimens examined — **CZECH REPUBLIC, Bohemia**, Prague-Radotín, under *Alnus glutinosa*, J. Borovička n° JB2010-2515; Prague, Reporyje, herb. J. Borovička BORE2008-9 (part in LIP). **ESTONIA, Tartu**, Jänese matkarada/Kvissentali, *Alnus incana*, 24 September 2010, L. Tedersoo 110319 (TU); Lülli, 58°27.5′N 26°49′E, *Alnus incana*, 2 October 2010, L. Tedersoo 110349 (TU). **FRANCE, Ain**, Vanchy, calcareous sand pit, under a small *Alnus glutinosa* in a watercourse, R. Fillion & P.-A. Moreau, 1 May 1999, P.-A. Moreau 99050110 (LIP, as "*A. pseudoscolecina*"); **Nord**, Trélon, *A. glutinosa*, 25 April 1999, J.-J. Wuilbaut 99042503 (LIP); Zuydcoote, fixed dune, under a single *Alnus glutinosa* along a sandy path, 9 November 2008, herb. P.-A. Moreau 08110901 (LIP); **Pas-de-Calais**, Evin-Malmaison, under *Alnus incana* planted in a periurban park, on wet clay-calcareous soil along a ditch, 30 October 2007, leg. A. Hayet & P.-A. Moreau, P.-A. Moreau 07103002 (LIP); **Savoie**, la Perrière, under *Alnus incana* along a rivulet in a *Fagus* forest, 780 m, 26 August 2010, P.-A. Moreau 10082610 (LIP); Beaufort, la Turnaz, with young *Alnus incana* in a mineral river bed, 1015 m, 28 August 2010, P.-A. Moreau 10082802 (LIP). **SLOVENIA**, *Alnus incana*, L. Tedersoo L7054 (TU). **SWEDEN, Jämtland**, Östersund, Rannåson, *Alnus incana* on calcareous gravel, 26 September 2007, leg. H. Lindström, H. Lindström 06.373 (part in LIP); **Skåne**, Ivö, Ivö klack, 56.139766°N 14.403568°E, under *Alnus incana, Salix* and *Betula* on calcareous clay, poor in organic matter, 22 October 2010, K. Gillen, K. Hansen, L. Örstadius and I. Olariaga, F-176866 (S, as "*Alnicola* cf. *escharoides*". **SWITZERLAND, Graubünden**, Filisur, leg. U. Peintner, 18 September 1998, IB1998/0446 (IB, as "*Alnicola escharoides*"); Rothenbrunnen, under *Alnus incana* on black alluviums, alt. 600 m, leg. P.-A. Moreau & B. Senn-Irlet, 1 September 2006, P.-A. Moreau 06090104; Alvaneu-Bad, under *Alnus incana*, 600 m, 1 September 2006, leg. V. Queloz, P.-A. Moreau 04090104 (LIP); **Bern**, Kandersteg, Filfalle, 1200 m, *Alnus incana* on calcareous soil, 30 September 2003, leg. H. Woltsche, P.-A. Moreau (LIP); *idem*, *A. incana* along a stream, on black alluvions, 22 July 2004, leg. B. Senn-Irlet & P.-A. Moreau, P.-A. Moreau 04072201 (LIP).

GenBank accession numbers (Moreau et al. 2006, Rochet et al. 2011) — **ITS1-5.8S-ITS2**: AF325630, HQ714705, HQ714709, HQ714765; **GPD**: HQ714627, HQ714628, HQ714648; **RPB2**: HQ714839, HQ714844, HQ714889; **V9**: HQ714530, HQ714534, HQ714581.

Ecology and distribution— With *Alnus incana*, more rarely *A. glutinosa*, usually on mineral-rich substrates, typically on black alluviums on river banks in alpine valleys (Alps), but also on coastal calcariferous sands (Northern France) or chalk in disturbed continental sites; known from lowland to montane altitudes (1200 m), from France to Estonia. Probably strictly basophilic, widespread in Europe and locally abundant.

Observations — This species is easily recognizable in the field by its general yellow colour when young, persistent in lamellae with age, non-striate pileus (when young), and a preference for basic mineral-rich sedimentary substrates.

It is typically found under *Alnus incana* on river banks in alpine regions, where it seems frequent and locally dominant, but also in plantations on calcareous soil, and a single collection from calcareous sand dunes under *Alnus glutinosa* in Northern France, what suggests an oro-septentrional distribution. It has probably been misidentified as *Alnicola escharoides* by various mycologists, despite the mild taste, and shorter basidiospores and cystidia that are usually described for this variously interpreted species (Moreau 2005; Fernández Sasia & Moreau 2011).

The closest species is *Alnicola longicystis*, which has the same biogeographical distribution but seems to prefer humus-rich or more acidic soils. Macroscopically it can be possible to misidentify old or single specimens of the two species; microscopically cystidia shape and size make a clear distinction between them. Analysis of ITS sequences clearly separate these species (Rochet et al. 2011).

Discussion

The identity of *Alnicola badia*

Alnicola badia is one of the most common agarics associated with *Alnus alnobetula* and one of the first (with *A. luteolofibrillosa* and *A. submelinoides*) described under this plant, but paradoxically one of the less documented in the difficult genus *Alnicola*. Kühner (1926) described *A. badia* from a single collection, a provision he wrote later (1931: 239): "... récolte unique sur laquelle nous avions cru pouvoir baser une espèce indépendante de *N. escharoides*", with a detailed description of this unique material. "Praz Joseph," now called "Praz Juget," is a locality of the village of La Perrière (Gros 1973), close to Bozel (Savoie), at low subalpine level (1890 m), with a northern exposure; the only alder species found there is *Alnus alnobetula*. In this locality Kühner also found two species exclusively associated with *Alnus alnobetula* (Basso 1999): *Lactarius alpinus* Peck (illustrated by Kühner 1929a as "*L. subalpinus* R. Kühner" [nom. illegit.], also known as *Lactarius kuehneri* Joss) and *L. lepidotus* Hesler & A.H. Sm. (illustrated by Kühner 1929b as "*Lactarius griseus* Peck").

Unfortunately, this single collection did not give the young Kühner a clear concept of his *Alnicola badia*, and at that time he was not experienced in lowland alnicolous fungi. By contrast, his friend Marcel Josserand, an active mycologist familiar with wet lowland forests around Lyon, was experienced in a common species identified by René Maire as *Tubaria umbrina* (Maire 1930), found abundantly under *Alnus glutinosa*. Josserand was convinced that *Alnicola badia* and *Tubaria umbrina* were synonyms, and did his best to convince Maire and Kühner of his opinion (unpublished correspondence, coll. R. Kühner (G), and coll. R. Maire (MPU)). Kühner (1931: 240) hesitated to synonymize these taxa, but finally accepted Josserand's point of view (Kühner 1942: 1). He also rejected his own genus name *Alnicola* under the influence of Maire (Maire

1937), and together they formalized the synonymy between *A. badia* and *A. umbrina* under a new name, *Naucoria phaea*.

Despite his affirmations, Kühner's numerous unpublished notes and collections prove that he had never been really convinced with this synonymy, but failed to define the limits of his *A. badia*. The unpublished names "*A. phaeodisca,*" "*A. subescharoides,*" "*A. alnobetulae,*" "*A. phaea* from 1961," etc. in his abundant notes on collections made after 1954 under *Alnus alnobetula*, show his repeated attempts to compare his collections and to separate them from the common lowland species *A. umbrina,* to which he had become familiar after 1942. But he never completed this challenge (Kühner 1981) and never published any definitive decision about *A. badia* after 1931.

The epithet name *badia* is in fact quite deceptive for a species typically bicoloured when fresh, only turning red brown with age or on drying. We formerly (Moreau 2006a; Moreau et al. 2006) interpreted it erroneously as a dark-coloured species (provisionally named "*A. badiofusca*" in Rochet et al. 2011), before understanding the importance of pileus structure and pigmentation for the distinction of these species. Before clearly separating these two species, we had already intuitively separated them in the field by their general colours and pileus striations under the respective field names "*A. badia* pâle [light]" or "*A. badia* bicolore" (*A. badia*) and "*A. badia* sombre [dark]" or "*A. badia* rouge [red]" (= "*A. badiofusca*"). The type collection of *A. badia* (herb. R. Kühner, G) is small, only made of two fragmented pilei, but fortunately we could precisely observe pileipellis (typically catenulate with mainly smooth pigmentation) and basidiospores, and establish identity with our own collections.

Morphology and ecology in the *Alnicola badia* complex

Alnicola badia, although strictly associated with *Alnus alnobetula*, is morphologically not a very distinctive species. With the two other species described here, both associated with *Alnus glutinosa* and *A. incana*, it forms a small group of mainly orophilic species, sharing the following characteristics: 1) lack of reddish, ferruginous or fulvous tinges, 2) absence of any trace of partial veil, 3) mild taste, 4) abundant necrobasidia, 5) cheilocystidia with thickened wall and neck partly filled with yellow content, 6) pleurocystidia around lamella edge, and 7) medium-sized amygdaliform basidiospores with low punctuate ornamentation. Species in the *Alnicola umbrina* group ("*A. badiofusca*" ad int., *A. sphagneti, A. subconspersa, A. umbrina;* Rochet et al. 2011) differ by the presence of red-brown colours in lamellae and/or pileus even when young, and spores frequently fusiform. *Alnicola citrinella* P.-A. Moreau & A. de Haan (= *A. escharoides* sensu auct.; de Haan & Moreau 2012), the most common *Alnicola* species under *Alnus glutinosa* and *A. incana*, differs by absence of pleurocystidia, bitter taste, and non-striate pileus.

Alnicola longicystis is macroscopically closest to *A. badia*. Its distinctive features include the distinctly bicoloured pileus (especially on young specimens) and distinct yellow tones in young lamellae, contrasting strongly with the typical grey-brown apex of stipe. Its distribution is apparently wide but irregular. It especially frequent under *Alnus incana* in the Alps but also found occasionally under *Alnus glutinosa* on peaty ground in lowlands, and also occurs at montane levels in the Pyrenees where *Alnus glutinosa* fills the natural niche of *A. incana* as known from the Alps. When *Alnus alnobetula* and *A. incana* grow intermixed, as in some localities in the Alps, the grayish to pale cream-yellow colour of lamellae and the very weakly striate pileus of *A. badia* are good field characters as compared to the clearly yellowish lamellae and distinctly striate pileus of young specimens of *A. longicystis*. Old or too wet specimens are almost impossible to recognize without a rigorous microscopic analysis.

Alnicola xanthophylla is also a very distinct species, easily separated from *A. longicystis* (with which it can grow closely intermixed in wet peaty *Alnus–Picea* forests on rich ground, as observed in several sites in Savoy) by the uniformly yellow colours of fresh basidiomata, slightly striate pileus, and absence of gray colour on the stipe apex even on youngest stages. Both species should be confused with *Alnicola striatula* (P.D. Orton) Romagn., a species with pale colours (not bright yellow; Orton 1960: 322), striate pileus, "amygdaliform-limoniform" and verrucose basidiospores and lanceolate cystidia, which belongs to the *Alnicola umbrina* complex (see Moreau, 2004, 2006). An updated identification key including the new taxa described here will be the object of a further publication.

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A new species of *Xerocomus* from Southern China

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Abstract — *Xerocomus puniceiporus*, discovered from Heishiding National Nature Reserve in Guangdong province of China, is described as new. The new species is morphologically distinctive because of its small basidioma, greyish ruby to purplish red pileus hairs or scales, reddish purple stipe, and yellow tubes with reddish purple pores. Its rDNA ITS sequence differs from any known sequence of *Xerocomus* and *Boletus*. The holotype is deposited in the Fungal Herbarium of Guangdong Institute of Microbiology (GDGM).

Key word — taxonomy, *Boletales*

Introduction

Xerocomus, which is considered to have a broad concept, is a heterogeneous mixture of several groups of species (Singer 1986, Ladurner & Simonini 2003) and is not monophyletic (Šutara 2008). Some mycologists have incorporated *Xerocomus* into *Boletus*, whereas others still treat it as an independent genus (Watling & Hills 2005, Hills 2008). At least 45 *Xerocomus* species have been reported in China (Bi et al. 1993, 1997; Chiu 1948, 1957; Li & Song 2000, 2003; Teng 1939, 1963; Zang 1996, 2006; Zang et al. 2001, 2002; Zang & Petersen 2004; Zhang et al. 2001). Recently, when tidying the bolete specimens collected from Heishiding National Nature Reserve in Guangdong province of China, we found a species different from any other bolete known from China. It is consistent with the definition of *Xerocomus* following the opinions of Watling & Hills (2005) and Šutara (2008). Further study revealed that as a new species, which we formally describe below. The holotype is deposited in the Fungal Herbarium of Guangdong Institute of Microbiology (GDGM).

Plate 1. *Xerocomus puniceiporus*.
a. Basidiomata. Bar = 20 mm. b. Basidiospores under scanning electron microscope

Materials & methods

Specimens were annotated and photographed in the field, and dried in an electric drier. Colour description was according to Kornerup & Wanscher (1978). Tissue sections were mounted in 5% KOH for microscopic examination. At least 30 basidiospores were measured. Basidiospore dimensions follow the notation (a–)b–c(–d), with b–c representing 90% or more of the measured values and with extreme values "a" and "d" shown in parentheses. Q = length/width ratio of an individual basidiospore, Q_m = average Q of all basidiospores ± sample standard deviation, and n = number of spores measured per specimen.

Genomic DNA was isolated from dried specimens and the ITS1-5.8S-ITS4 segment from the ribosomal DNA (rDNA) was amplified with primer sets ITS1 (5'-CTT GCG TTG ATT ACG-3') and ITS4 (5'-TCC TCC GCT TAT TGA TAT GC-3') by polymerase chain reaction (PCR) techniques. Amplified products were examined with agarose gel electrophoresis using a 2kb DNA marker. The amplified PCR product was directly sequenced and the datum is deposited in GenBank.

Taxonomy

Xerocomus puniceiporus T.H. Li, Ming Zhang & T. Bau, **sp. nov.** Plate1, Fig. 1

MycoBank MB 563347

Differs from *Boletus aokii* by its purplish red pores, nearly unchanging reaction when injured, and small basidiospores.

Type: China, Guangdong Province, Fengkai County, Heishiding National Nature Reserve, 1 July 2010, TaiHui Li & ChunYing Deng (**Holotype**, GDGM 27443; GenBank JF514559).

Etymology: *puniceiporus* refers to the purplish red pore-surface or pore-edge.

Pileus 20–25 mm broad, fleshy, convex to expanded, greyish ruby (12E5) to greyish Magenta (13E5) in the mass, mixed with greyish red (11D5), tomentose to fibrillose or villose, soon becoming areolate, and with tufts of greyish ruby (12E5), greyish Magenta (13E5) to purplish red (13B7) hairs or villose scales on

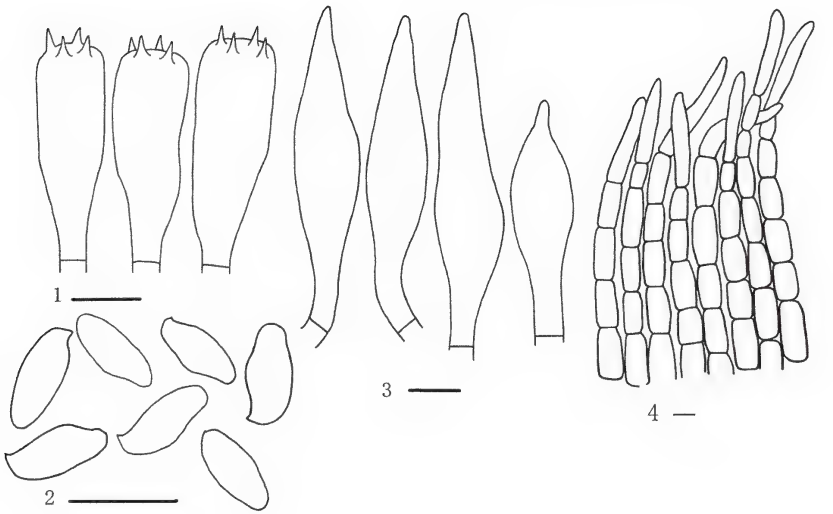

Fig. 1. Microscopic features of *Xerocomus puniceiporus*.
a. Basidia; b. Basidiospores; c. Pleurocystidia; d. Pileipellis. Bars = 10 μm.

surface, not viscid; with a narrow purplish red (13B7) zone and slightly incurved at margin. Exposed background or context nearly white, pinkish white, yellowish white (1A1), pinkish (1A2) to light purplish pink (14A2). Flesh 2.5–4 mm thick at center, soft, white (1A1), nearly unchanging to slightly blueing (21A2, 22A2) when exposed. Tubes 1.5–2.5 mm deep, decurrent, light yellow (2A5), lemon yellow (2B5) to greenish yellow (2C6), pores 1–2 mm wide, angular, somewhat radially elongated or lamellate close to stipe, with a very narrow purplish red (13A7) pore-surface or edge. Stipe 20–27 × 2–3 mm, central, cylindrical, equal to slightly enlarged downwards, purplish red to magenta (13B7, 13C7), with purplish red furfuraceous scurfs, slightly or obscurely striate, solid, brittle, with white mycelium at base; stipe context white (1A1), nearly unchanging to slightly blueing (21A2, 22A2) when exposed.

Basidiospores (7.2–)7.8–9.8(–10.6) × (3.5–)3.9–4.3(–4.8) μm, Q = (1.88–)2.0–2.33(–2.51), Q_m = 2.20 ± 0.15, n = 30, ellipsoid to ellipsoid-fusiform, smooth, pale yellowish brown to olive yellow, thin-walled. Basidia 4-spored 27.0–35.0 × 7.5–11.0 μm, clavate, hyaline to yellowish white; sterigmata 1.4–2.7 μm long. Pleurocystidia 48.0–70.0 × 12.0–15.0 μm, fusoid ventricose to fusoid, thin-walled, with hyaline to yellowish. Hymenophoral trama subparallel to nearly bilateral type with hyphae of the lateral strata loosely arranged, hyaline to yellowish, 7.8–15 μm broad. Pileipellis composed of tufts of erect hyphal elements 9.8–13.2 μm broad, but initially a characteristic palisadoderm, with brownish yellow to yellowish. Clamp connections absent in all tissues.

Ecology and Distribution — Solitary or scattered on soil with humus and debris under conifers mixed with other broadleaf trees; June to July. Only known from the type locality in South China (Guangdong).

Comments — According to Šutara (2008), *Xerocomus* s.l. can be divided into five genera as *Xerocomus* s. str., *Phylloporus*, *Xerocomellus*, *Hemileccinum,* and *Pseudoboletus*. Following this classification, our new species would be placed in Šutara's *Xerocomellus* based on the smooth as observed under the scanning electron microscope (Plate 1b), the hymenophoral trama comprises an intermediate structure between the boletoid and phylloporoid types with hyphae of the lateral strata not touching each other, and the pileipellis at the initial stage is composed of a characteristic palisadoderm (Šutara 2005, 2008). However, when compared with the other species within *Xerocomellus* group possessing a similar cracking pileus and large angular pores, *Xerocomus puniceiporus* can be distinguished from other species by the combination of small basidiomes with greyish ruby to purplish red hairs or scales on the pileus, yellow tubes with purplish red pores, nearly unchanging to slightly blueing context, and purplish red scurfs on the stipe. Among the other bolete groups, *Boletus aokii* Hongo macroscopically resembles the new species to some extent in size, pileus colour, yellow tubes, and angular pores, but it has longer basidiospores (9–13.5 × 4–5 μm), yellow pores, and a noticeable blueing reaction on tubes and flesh when injured (Hongo 1984, Zang 2006).

The nrDNA-ITS sequence (660 bp) of *X. puniceiporus* (JF514559) differs from any known sequences of *Xerocomus* and *Boletus*. A Blast search of GenBank produced as the closest matches several unknown *Xerocomus* species (AY372287, AY372285, DQ066413, DQ066412, DQ066378), with only 87% maximal identities. Therefore, we distinguish *Xerocomus puniceiporus* as a new species based on both morphological and molecular characters.

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Nomenclatural and taxonomic notes on *Calvatia* (*Lycoperdaceae*) and associated genera

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Abstract — Various nomenclatural aspects pertaining to author citations, orthography and the validity of names in the genus *Calvatia,* and, in one instance, *Bovista,* are discussed. The name *Calbovista subsculpta* var. *fumosa* is validated and the biogeographic status of *Calvatia gigantea* in southern Africa is discussed. The name *Calvatiella lioui* is lectotypified.

Key words — *Bovista cacao, Calvatia sericella, Calvatia sinclairii, Calvatia versipora, Calvatiella lioui*

Introduction

In the course of our ongoing study of the genus *Calvatia* Fr. in southern Africa, we are continually encountering noteworthy facts and odd snippets of information, some of which—especially those pertaining to non-southern African taxa—are unlikely to find mention elsewhere in our papers on the southern African *Lycoperdaceae.* Individually, some items might perhaps be regarded as rather trivial, but collectively it all adds up to a substantial body of information that might be of value to other workers in the field as well as, in a few cases, even serve as stimulus for further investigation. A selection of those (often purely nomenclatural) items of information is presented in this miscellany of short notes. All references to the International Code of Botanical Nomenclature (ICBN) pertain to the 'Vienna Code' (McNeill et al. 2006).

1. Validation of the name *Calbovista subsculpta* var. *fumosa*

Calbovista subsculpta* var. *fumosa A.H. Sm. ex J.C. Coetzee & A.E. van Wyk, **var. nov.** MycoBank 513113

"*Calbovista subsculpta* var. *fumosa*" A.H. Sm., Mycopathol. Mycol. Appl. 26: 396. 1965, **nom. inval.**

Description (Latin and English) — Smith (1965).

Type — United States, Idaho, Bonner Co., Dickensheet Campground, Priest River, Kaniksu National Forest, gregarious under *Pinus contorta*, A.H. Smith 71347, 21 October 1964. [**Holotype**, MICH].

Key characters — See Smith (1965).

Comments — When Morse (1935) erected the monotypic genus *Calbovista,* no Latin diagnosis or reference to any previously published Latin diagnosis was provided, making the names "*Calbovista*" Morse and "*Calbovista subsculpta*" Morse invalid according to ICBN Art. 36.1. Consequently, the varietal name "*Calbovista subsculpta* var. *fumosa*" (Smith 1965) was also invalid in terms of ICBN Art. 43.1, which rules that the name of a taxon below the rank of genus is not validly published unless the name of the genus or species to which it is assigned has been validly published. Although Seidl (1995) validated Morse's invalid generic and specific names, no consideration was given to Smith's varietal name. That situation is here rectified by formally validating the name.

2. The names *Calvatia umbrina* and *Bovista cacao* revisited

Although the fungus that has gone under the above two names was properly described in Lloyd (1904a: 2), it is evident from Lloyd's discussion that he regarded *Calvatia umbrina* as merely provisional, thereby making "*Calvatia umbrina*" Lloyd invalid according to ICBN Art. 34.1(b). Nonetheless, despite this and despite Stevenson & Cash's (1936) exclusion of *C. umbrina* from their catalogue of new fungus names proposed by Lloyd, Zeller & Smith (1964) continued to use Lloyd's invalid name.

This error was perpetuated by Ponce de León (1975) when he transferred *C. umbrina* to the genus *Bovista.* Ponce de León accepted Lloyd's provisional name but, realising that the epithet *umbrina* was unavailable in *Bovista* (having been used previously by Bottomley (1948) for a different fungus), proposed the new name *Bovista cacao* P. Ponce de León. However, since *C. umbrina* is invalid and thus has no status under the ICBN, Ponce de León should not have treated *Bovista cacao* as a nomen novum, but as a species novum which, in the absence of a Latin diagnosis, must be rejected as invalid according to ICBN Art. 36.1.

A re-examination of the original (and apparently only) collection of this fungus [U.S.A., California, Mountain View, on the ground, Erhorn s.n. (Lloyd Myc. Coll. 20679, BPI)] is required and, if found to be a good species, the name needs to be validated. Kreisel (1992, 1994) did not include this fungus in his survey and key to the genus *Calvatia.*

3. On the identity of *Calvatia sericella*

Calvatia sericella (Berk.) Lloyd ex J.A. Stev. & E.K. Cash, Bull. Lloyd Libr. Bot. (35): 173. 1936.

≡ *Lycoperdon sericellum* Berk., Hooker's J. Bot. Kew Gard. Misc. 3: 171. 1851.

Holotype — India, Darjeeling, 7000 feet, on the ground, Hook fil. 32. [K!]

As far as could be ascertained, the combination *Calvatia sericella* was first validly published in Stevenson & Cash (1936). They ascribed the combination to Lloyd (1904b: 2), but as Lloyd did not definitely associate the epithet with the genus name, he failed to create a combination according to ICBN Art. 33.1 + Ex. 2. Demoulin (1971) believed that *C. sericella* probably was conspecific with *Calvatia excipuliformis* (Scop. : Pers.) Perdeck, although Lloyd (1904b) and Van Overeem (1927) suggested a relationship with *Calvatia gardneri* (Berk.) Lloyd [= *Calvatia pyriformis* (Lév.) Kreisel]. However, after having examined the type material at K (consisting of three specimens in the *Lycoperdon sericellum* type folder but filed under *C. excipuliformis*), we are convinced that it represents neither *C. excipuliformis* nor *C. pyriformis* and—based on macroscopic similarity, spore morphology, and the presence of conspicuous, widely gaping perforations in the branched, septate capillitium—strongly suspect conspecificity with the well-known *Calvatia rugosa* (Berk. & M.A. Curtis) D.A. Reid. Should that be the case, the name *C. sericella* will enjoy priority over *C. rugosa,* since its basionym (*L. sericellum*) antedates the basionym of *C. rugosa* (≡ *Lycoperdon rugosum* Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10: 345. 1868) by 17 years. Molecular analysis of the relevant type specimens should throw more light on this intriguing question.

4. A matter of orthography: '*versispora*' or '*versipora*'?

The fungus originally described by Lloyd (1915: 7–8) as *Calvatia versipora* does not belong to the *Lycoperdaceae* at all. It is, in fact, the anamorph of *Laetiporus sulphureus* (Bull. : Fr.) Murrill (Kreisel et al. 1983, Stalpers 1984, Reid 1985), which Stalpers (1984) transferred to the genus *Sporotrichum* Link : Fr. [as *Sporotrichum versisporum* (Lloyd) Stalpers].

According to Lloyd (1916), the name *C. versipora* was an '...original blunder...' and he therefore suggested a change to *Calvatia versispora* since that '...would better indicate the idea....' According to ICBN Art. 51.1 and 60.1, however, changes such as this are not permitted. Nonetheless, various later authors such as Stevenson & Cash (1936), Kreisel et al. (1983), Stalpers (1984), and Reid (1985), adopted Lloyd's proposed 'correction.' Stalpers (1984) defends this as follows: 'The code allows the correction of printing errors and thus the epithet '*versispora*' is used....' Perusal of Lloyd's (1915) original publication revealed, however, that the name of this fungus appears in print not only once, but at least three times (once on p. 4 and twice on p. 7) and, in all cases, as '*versipora*'. As a result of this consistent use by Lloyd (1915), we are much more inclined to believe that the use of the original '*versipora*' was intentional, and that it should not merely be dismissed as a correctable typographic error. We have little doubt that the blunder referred to by Lloyd (1916) represents an error of semantics and not of typography. Consequently we believe that Lloyd's original spelling should also be retained in later combinations derived from the original name.

5. Correct author citation for the superfluous combination *Calvatia bovista* (Pers. : Pers.) Kambly & Lee

T.C.E. Fries's (1921) transfer of *Lycoperdon bovista* Pers. : Pers. to the genus *Calvatia* [as *C. bovista* (Pers. : Pers.) T.C.E. Fr., an illegitimate later homonym of *C. bovista* (L.) T. Macbr.] went unnoticed by many authors, including Kambly & Lee (1936) who, in their paper on the gasteromycetes of Iowa, also made the transfer and have since then often been credited with the combination *Calvatia bovista* [basionym: *L. bovista* Pers. : Pers. {= *Calvatia utriformis* (Bull. : Pers.) Jaap}], not to be confused with *Calvatia bovista* (L.) T. Macbr. [≡ *Lycoperdon bovista* L. {= *Calvatia gigantea* (Batsch : Pers.) Lloyd}]. Kambly & Lee's combination is, however, illegitimate on two counts: (1) it is superfluous and (2) (like the Fries combination) it is a later homonym of *C. bovista* (L.) T. Macbr.

Establishing the correct author citation for Paul Kambly and Robert E. Lee's isonym proved to be an unexpected and time-consuming irritation. Throughout the literature, the name has merely been cited as "*Calvatia bovista* (Pers. : Pers.) Kambly & Lee." With Brummitt & Powell (1992) listing no fewer than 29 Lees as authors of plant names, the abbreviation requires some refinement. Unfortunately, however, Brummitt & Powell (1992) list not one, but two authors as Robert E.... Lee, neither of whom is cited as an author of fungal names. Robert Edward Lee is listed for his algal names, while Robert Edwin Lee is remembered as an author of spermatophyte names. Who then collaborated with Kambly on the 1936 paper on the gasteromycetes of Iowa? Was it Robert Edward, Robert Edwin, or someone entirely different? The literature available to us yielded no clues.

The problem was eventually solved after repeated enquiries revealed the existence of a 1932 MS thesis on gasteromycetes by one 'Robert Edward Lee' in the University of Iowa library. This 'discovery' left us with little doubt that Robert Edward was our man and that the correct author citation for Kambly & Lee's illegitimate combination should be *Calvatia bovista* (Pers. : Pers.) Kambly & R.Ed. Lee.

6. The status of *Calvatia gigantea* in South Africa

Bottomley's (1948) inclusion of *C. gigantea* in her list of South African gasteromycetes was based on a single, late 18th century, Thunberg collection of a specimen(s?) found in June in hilly terrain outside Cape Town (Thunberg 1800, 1823). Thunberg's designation of his material as *Lycoperdon bovista* sensu Linnaeus (= *C. gigantea*) was an error, but understandable for the time. It is inexplicable however, how this error could have been perpetuated in Bottomley (1948), which has led to other authors (e.g. Kreisel 1992, 1994) also citing *C. gigantea* as occurring in South Africa. Thunberg (1800, 1823) described his material as follows: '...globosum, lacero-dehiscens, stipite validissimo, clavato-

ventricoso, carne alba, seminis atris.' The reference to 'white flesh' indicates an immature specimen, which would have made identification difficult. The distinct stipe, however, clearly excludes Thunberg's material from the stipeless *C. gigantea,* which is, apart from Thunberg's record, not known to occur in the Cape Town area or anywhere else in South Africa. Thunberg's description is, however, very reminiscent of an immature *Calvatia cyathiformis* (Bosc) Morgan, which is, from our own experience, the most common large puffball occurring in the Cape Peninsula area. We would be surprised if the Thunberg specimen did not represent an immature *C. cyathiformis* specimen.

Thunberg's collection does not seem to have survived. In the Thunberg herbarium at UPS there is only a single sheet (no. 27495, with no locality indicated) filed under *Lycoperdon bovista.* A photograph of the sheet clearly shows the specimens mounted on it to be globose, stalkless, and dehiscing by means of a relatively wide ostiole. These are characteristics of *Bovista,* and the sheet also bears the inscription '*Bovista nigrescens.*' In addition to the missing locality information on the sheet, the stalkless nature of the specimens at UPS clearly separate them from Thunberg's '*L. bovista*' specimen(s?) from the Cape.

In July 1985 a huge puffball, unfortunately still immature but macroscopically very reminiscent of *C. gigantea,* was collected in a garden in Durban (T.D. Steinke s.n.) and sent to PREM for identification (PREM 48248). A small piece of the carpophore was later sent to Kew, on which Dr. Derek Reid commented in a letter to the PREM correspondent (copy of letter filed in the *Langermannia* sp. nov. file at K!): 'It is not *L. gigantea*...' because the spores '... are smaller and much less ornamented... [and] ...the capillitium is also perforate.' He concluded: '... I am inclined to agree with you that the specimen may well represent a new species of *Langermannia* but I feel it would be unwise to describe it on this abnormal specimen.'

No other southern African material of *C. gigantea* could be found in any South African herbarium, and a search at K also failed to locate anything from the African continent. A specimen from Kenya in a box at K, labeled *Langermannia gigantea*, represents *Calvatia argentea* (Berk) Kreisel. The U.S. National Fungus Collections also contain no record of this fungus from Africa (Farr & Rossman 2006). Therefore, in the absence of any substantiating evidence, the occurrence of *C. gigantea* in South Africa remains unconfirmed.

7. Identity of *Lycoperdon sinclairii* confirmed

Calvatia sinclairii (Berk. ex Massee) Lloyd, Lycoperd. Australia: 37. 1905.

≡ *Lycoperdon sinclairii* Berk. ex Massee, J. Roy. Microscop. Soc. London 1887: 716. 1887.

Holotype — New Zealand, Nelson 1500 ft., on the ground, Sinclair s.n. [K!]

Calvatia sinclairii has in the past been cited as a synonym of *C. utriformis* (Kreisel 1962, Zeller & Smith 1964) and, according to Demoulin (1971),

it is close to *C. utriformis*. Kreisel (1989), however, regarded it as a doubtful synonym of that species. After having had the opportunity to examine the type specimen at K, however, we are confident that *C. sinclairii* is conspecific with, and should indeed be regarded as a later synonym of, *C. utriformis*.

8. On the status of *Calvatia purpurea*

"***Calvatia purpurea***" (O.F. Müll. : Fr.) I.R. Hall, P.K. Buchanan, Y. Wang & A.L.J. Cole, Edible and poisonous mushrooms: 174. 1998, **comb. inval.**

≡ *Clavaria purpurea* O.F. Müll., Fl.dan. 14: t.837 f.2. 1780 : Fr., Syst. Mycol. 1: 480. 1821.

This combination first appeared in a list of fungi published in Hall et al. (1998), and both MycoBank (http://www.mycobank.org, 30-3-2011) and Index Fungorum (www.indexfungorum.org, 30-3-2011) accepted it as a good name, citing it as "*Calvatia purpurea* (Lloyd) I.R. Hall, P.K. Buchanan, Wang{?} & Cole" with *Bovista purpurea* Lloyd as basionym. That, however, is not correct. The combination "*Calvatia purpurea*" was created unintentionally and is an error to be ignored. A mistake was made in compiling the list in Hall et al. (1998); the entry should have read *Clavaria purpurea* O.F. Müll. : Fr., not "*Calvatia purpurea*" (Dr. I.R. Hall, pers. comm.). Since the combination was published without indicating the basionym and as it is also not accepted by the authors who inadvertently created it, the name is invalid according to ICBN Art. 33.3 and 34.1(a).

9. Lectotypification of *Calvatiella lioui*

Calvatiella lioui C.H. Chow, Bull. Fan Mem. Inst. Biol., Bot. 7: 93. 1936.

LECTOTYPE (**designated here**) — plate III of Chow (1936).

Calvatiella lioui was originally described from a single specimen found in the herbarium of the National University of Peking (Chow 1936). This specimen disappeared during World War II, however (Kreisel & Calonge 1993). In view of this holotype loss, the only remaining original material associated with the name is here formally designated as lectotype of *Calvatiella lioui* according to ICBN Art. 7.10, 7.11, 9.9 and 9.10. Based on the description and illustrations in Chow (1936), Kreisel & Calonge's (1993) relegation of *Calvatiella lioui* to synonymy under *Calvatia utriformis* certainly seems probable but, in the absence of the holotype, cannot be corroborated.

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visits to the Mycological Herbarium at Kew is acknowledged with appreciation. Prof. Vagner G. Cortez of Universidade Federal do Paraná (Brazil) and Dr. Taiga Kasuya of the University of Tsukuba (Japan) are thanked for valuable comments and critically reviewing an earlier draft of this paper.

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New combinations and notes in clavarioid fungi

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Abstract — The revision of several families of clavarioid fungi in the Iberian Peninsula necessitated new combinations and names to be used for the Iberian fungal flora. Eight new combinations are proposed in *Clavulina*, *Ramariopsis*, and *Typhula*, and nomenclatural and taxonomic comments are provided in each case. Lectotypes are designated for *Clavaria contorta*, *Clavaria fistulosa* (type species of *Macrotyphula*), and *Clavaria phacorrhiza* (type species of *Typhula*). The genus *Macrotyphula* is reduced to synonymy under *Typhula*.

Key words — *Clavariaceae*, *Clavulinaceae*, *Typhulaceae*, nomenclature, taxonomy

Introduction

Clavarioid fungi form an artificial assemblage of fungi, since clavarioid fruitbodies have evolved in several lineages (Parmasto 1965, Pine et al. 1999, Dentinger & McLaughlin 2006, Hibbett 2007). However, for practical reasons, clavarioid fungi have often been the target group for monographs and smaller papers (Corner 1950, Petersen 1988, Dentinger & McLaughlin 2006). During the last years, a monograph that deals with some families of clavarioid fungi (*Clavariaceae*, *Clavulinaceae*, *Pterulaceae*, and *Typhulaceae*) has been completed as a result of a PhD (Olariaga 2009), following the framework of Flora Mycologica Iberica (Tellería & Melo 1995). The taxonomic and nomenclatural revision of many names and type collections in the light of current phylogenetic knowledge has necessitated the creation of new names to be used in the context of the Iberian fungal flora. Thus, the purpose of this work is to effectively publish nomenclatural novelties required as a result of the mentioned monograph (Olariaga 2009).

Materials & methods

Herbaria abbreviations follow Holmgren & Holmgren (1998). The collections examined in this study are deposited in BIO, G, MA, PORTU (Mycological Society of Portugalete, Biscay), S, SEST (Natural Science Society of Sestao, Biscay), and UPS herbaria. Abbreviations of author names, periodicals, and non-periodical publications follow Kirk & Ansell (2003), Bridson & Smith (1991), and TL2 (Stafleu & Cowan 1976, 1979), respectively. All validly published homotypic synonyms are given under each new combination.

Taxonomy

Clavulina incarnata (Corner) Olariaga, **comb. et stat. nov.**

MycoBank 563526

≡ *Clavulina cristata* var. *incarnata* Corner, Ann. Bot. Mem. 1: 692. 1950.

Of the few *Clavulina* species known to have cystidia (Corner 1970), *C. cristata* var. *incarnata* is the only taxon that has been recorded in Europe (Corner 1950, Pilát 1958). Corner (1950) described the variety for two British collections that developed a pink to grayish drab colour and, above all, possessed cystidia. He granted the taxon the rank of variety, not without noting that it might deserve the species rank. This taxon would differ from *C. cristata* (Holmsk. : Fr.) J. Schröt. as treated by Olariaga et al. (2009) in the early development of pink to grey tones, presence of cystidia, and the lack of profusely cristate apices. Two recent Swedish collections that match Corner's description have enabled the senior author to confirm these differences and thus to propose a new combination to accommodate the only cystidiate *Clavulina* species known in Europe.

Specimens examined—**SWEDEN. Uppland**: Sollentuna parish, Hansta naturreservat, 33VXF64579094, under *Quercus robur*, *Corylus avellana*, *Populus tremula*, and *Fraxinus excelsior* on rich ground, 08/IX/2010, Hansen, Gillen & Olariaga, S-F197088; 33VXF6462690942, 14/IX/2010, Olariaga, S-F197089. Stockholm, Hagaparken, under *Pinus* and *Betula*, on acidic ground, 24/X/2011, Zamora & Olariaga, BIO-Fungi 16400.

Clavulina reae Olariaga, **nom. et stat. nov.** [non *Clavulina gracilis* Corner 1950].

MycoBank 516723

≡ *Clavaria cinerea* var. *gracilis* Rea, Trans. Brit. Mycol. Soc. 6: 62. 1918 ["1917"].

≡ *Clavulina cinerea* var. *gracilis* (Rea) Corner, Ann. Bot. Mem. 1: 309. 1950.

Morphological and phylogenetic studies among the European *Clavulina* taxa indicate that more species than are generally accepted are present in Europe. Olariaga et al. (2009) showed that specimens identified as *C. cinerea* var. *gracilis* that conform to the original description by Rea (1918) form a well-supported clade that should be assigned to a species. Because the epithet *gracilis* is not available, we propose a substitute with a new epithet honouring the memory of Carleton Rea. No type material is extant at K (Begoña Aguirre-Hudson, pers. comm.).

Ramariopsis bispora (Schild) Olariaga, **comb. et stat. nov.**

MycoBank 516724

≡ *Ramariopsis kunzei* var. *bispora* Schild, Westfälische Pilzbriefe 8: 30. 1970.

The type material deposited in Schild's personal herbarium could not be traced. However, after examining the comprehensive original description and further Iberian specimens, we consider that *Ramariopsis kunzei* var. *bispora* deserves to be recognized at the species level. In addition to the 2-spored basidia and the absence of clamps (attributed to parthenogenesis as a reproduction mode), *R. kunzei* var. *bispora* differs macroscopically from *R. kunzei* (Fr. : Fr.) Corner in having smaller basidiomata and lacking pinkish patches in age. Microscopically, although bi-pyramidal crystals are present among the context hyphae of the branches in all the material examined, as Schild (1970) depicted, we have never observed crystals in the typical variety of *R. kunzei*. The narrower basal tomentum hyphae (2.5-3 µm) of *R. kunzei* var. *bispora* appear to be a good taxonomic character to separate the variety from *R. kunzei,* with hyphae 3-4 (5.5) µm diam.

Specimens examined—**SPAIN**. **Bizkaia**: Larrinagatxu, Izurtza, 30TWN2878, 280 m, under *Chamaecyparis lawsoniana* along a slope, 01/X/2003, Iglesias, Arauzo & Olariaga, BIO-Fungi 12383; Sopuerta, barrio Castano Viejo, 30TWN2464, 600 m, forest with *Fagus sylvatica* var. *purpurea* and *Chamaecyparis*, 01/VII/2004, Fernández-Vicente, PORTU 7100704 [as *Ramariopsis kunzei*], BIO-Fungi 12563. **Burgos**: Pantano de Ordunte, under *Chamaecyparis lawsoniana* on the soil, 07/X/2007, Pérez-Butrón, SEST 7100705 [as *Ramariopsis* sp.], BIO-Fungi 12567. **León**: Riaño, Puerto del Pontón, 30TUN3677, 1000 m, slope along the road, 01/X/2003, Olariaga, BIO-Fungi 9922. **Asturias**: Proaza, 29TQH4192, 280 m, under *Quercus ilex* on calcareous soil, 27/X/2002, Olariaga, BIO-Fungi 9705.

Ramariopsis luteonana (Schild) Olariaga, **comb. nov.**

MycoBank 516725

≡ *Clavulinopsis luteonana* Schild, Fungorum Rar. Icon. Color. 5: 28. 1971.

The type material could not be traced. The complete original description by Schild (1971) deals with a fungus with simple to forked fruitbodies, small smooth spores, and short basidia. This short basidia and the small spores make *Clavulinopsis luteonana* closer to *Ramariopsis kunzei* [type of *Ramariopsis* (Donk) Corner] than to *Clavulinopsis miniata* (Berk.) Corner (= *Clavulinopsis sulcata* Overeem, the type of *Clavulinopsis* Overeem). Furthermore, the Iberian material matching Schild's fungus in basidioma shape, presence of bi-pyramidal crystals, short basidia, and small spores also shows a very faint ornamentation in some spores when viewed through the light microscope. Hence, we believe that the species is better placed in *Ramariopsis.*

Specimens examined—**SPAIN**. **Bizkaia**: Korostadui, Iurreta, 30TWN2981, 140 m, under *Chamaecyparis lawsoniana* and *Pseudotsuga menziesii*, 17/X/2007, Iglesias, Arauzo & Olariaga, BIO-Fungi 12374.

Ramariopsis subumbrinella (S. Imai) Olariaga, **comb. nov.**

MycoBank 516726

≡ *Clavaria subumbrinella* S. Imai, Trans. Sapporo Nat. Hist. Soc. 13(4): 386. 1934.

≡ *Clavulinopsis subumbrinella* (S. Imai) Corner, Ann. Bot. Mem. 1: 392. 1950.

The type material could not be located. The original description by Imai (1934) noting small spores, small basidia, and branched basidiomata suggests a species of *Ramariopsis*. The Iberian material that matches in several aspects the original description shows a very low ornamentation in some spores through the light microscope, also typical of many *Ramariopsis* species.

Specimens examined—**SPAIN**. **Cádiz**: Parque Natural de los Alcornocales, Arroyo Carlos el Tiradero, 30SF61, 150 m, under *Pistacia lentiscus*, *Olea europaea* and *Quercus suber*, 26/XI/2003, Pérez-Daniëls & Olariaga, BIO-Fungi 10015. **Córdoba**: Córdoba, Arroyo Pedroches, 30SUG4398, 200 m, on bare soil under *Myrtus communis*, 5/XII/2003, Pérez Daniëls & Olariaga, BIO-Fungi 10224. **Segovia**: Prádena, El Nido del Cuervo, 30TVL4351, 1350 m, bajo *Ilex aquifolium*, 20/XI/1997, Pérez Daniëls, MA-Fungi 40223 [as *Clavulinopsis subtilis*], MA-Fungi 40225 [as *Clavulinopsis* sp.].

Typhula contorta (Holmsk. : Fr.) Olariaga, **comb. nov.**

MycoBank 516730

≡ *Clavaria contorta* Holmsk., Beata Ruris 1: 29. 1790 : Fr., Syst. Mycol. 1: 478. 1821.

≡ *Clavaria fistulosa* var. *contorta* (Holmsk.) Höhn., Öst. Bot. Z. 54: 425. 1904.

≡ *Clavaria fistulosa* f. *contorta* (Holmsk.) Bourdot & Galzin, Hyménomyc. France: 121. 1928 ["1927"].

≡ *Clavariadelphus fistulosus* var. *contortus* (Holmsk.) Corner, Ann. Bot. Mem. 1: 273. 1950.

≡ *Macrotyphula fistulosa* var. *contorta* (Holmsk.) Nannf. & L. Holm, Publ. Herb. Univ. Uppsala 17: 8. 1985.

≡ *Macrotyphula contorta* (Holmsk. : Fr.) Rauschert, Feddes Repert. Spec. Nov. Regni Veg. 98: 660. 1987.

Lectotype (**designated here**): Holmsk., Beata Ruris 1: pl. 12. 1790.

The epithet *contorta* has traditionally been used for specimens with irregular, wrinkled, or brain-like basidiomata. It has often been synonymized with *Typhula fistulosa* (Jülich 1984, Rauschert 1987, Berthier 1976) or considered a variety of it (Knudsen 1997), due to high morphological plasticity (Holmskjold 1790, Bourdot & Galzin 1928). However, some authors have noted that *T. contorta*-like basidiomata have larger basidiospores (Harper 1918, Corner 1950, Maas Geesteranus 1976, Breitenbach & Kränzlin 1986). Comparison of the examined *T. contorta* material with typical *T. fistulosa* collections supports this view. Accordingly, *T. contorta* is treated as an independent species in the Iberian revision of the group (Olariaga 2009), although further focused studies are desirable to confirm its identity. The reasons for accommodating this taxon in *Typhula* (Pers. : Fr.) Fr. are given under *T. fistulosa*.

Specimens examined—**FRANCE**. **landes** (40): Tartas, bois mort, 16/11/1987, G 110719, Gilles, [LY-Cl 349, as *Macrotyphula fistulosa* f. *contorta*]. **SPAIN**. **Araba**:

Gillerna, 30TQH1881, 750 m, *Alnus glutinosa* twigs, 7/XII/1985, Martínez-Irigoyen, BIO-Fungi 12614, BIO-Fungi 12615, *Alnus glutinosa* twigs, 18/I/1986, BIO-Fungi 12616, *Alnus glutinosa* twigs, 6/12/1986, BIO-Fungi 12617, *Corylus avellana twigs*, 30/XI/1985, BIO-Fungi 12613; Oleta, Aramaio, 30TWN3189, 600 m, *Corylus* or *Alnus glutinosa* twigs, 15/X/2004, Salcedo, BIO-Fungi 10516. **Ávila**: Barquillo, El Loscar, 29TOF8776, 970 m, *Alnus glutinosa* twig, 8/XI/2004, Sarrionandia & Olariaga, BIO-Fungi 10608. **Bizkaia**: Getxo, Martiartu, 30TWN0298, 100 m, *Alnus glutinosa* twigs, 22/XI/2003, Olariaga, BIO-Fungi 10107, BIO-Fungi 10105. **Cáceres**: Hervás, La Garganta, 30TTK5963, 790 m, *Alnus glutinosa* wood, 9/XI/2004, Sarrionandia & Olariaga, BIO-Fungi 10620. **Asturias**: Pigüeces, 30TQH1881, 750 m, *Alnus* stump, 6/X/2005, Olariaga, BIO-Fungi 11191. **Salamanca**: Candelario, 30TTK6571, 100 m, *Corylus avellana* twig, 8/XI/2004, Sarrionandia & Olariaga, BIO-Fungi 10641. **SWEDEN. Blekinge**: Karlskrona, Västra Mark, strandsnåret, på murkna algrenar, 10/XI/1946, Wikland 243, UPS F-124250 [as *Clavaria contorta*]. **västergötland**: Hisingen, Göteborg, Rya skog, på *Alnus glutinosa*, 26/XI & 9/XII/1999, Nordin, UPS F-124213 [as *Macrotyphula fistulosa* var. *contorta*].

Typhula fistulosa (Holmsk. : Fr.) Olariaga, comb. nov.

MycoBank 516731

≡ *Clavaria fistulosa* Holmsk., Beata Ruris 1: 15. 1790 : Fr., Syst. Mycol. 1: 479. 1821 [non Tode 1783].
≡ *Eriocladus fistulosus* (Holmsk. : Fr.) Lév., Ann. Sci. Nat., Bot., Sér. 3, 5: 159. 1846.
≡ *Clavariella fistulosa* (Holmsk. : Fr.) P. Karst., Rev. Mycol. (Toulouse) 3(9): 21. 1881.
≡ *Clavariadelphus fistulosus* (Holmsk. : Fr.) Corner, Ann. Bot. Mem. 1: 272. 1950.
≡ *Macrotyphula fistulosa* (Holmsk. : Fr.) R.H. Petersen, Mycologia 64: 140. 1972.

Lectotype (**designated here**): Holmsk., Beata Ruris 1: pl. 6. 1790.

This species was proposed as the type of *Macrotyphula* R.H. Petersen (Petersen 1972), a currently used generic name. Morphological comparison between *Macrotyphula fistulosa* and *Typhula phacorrhiza* [selected type species of *Typhula* (Donk 1933)] revealed the following morphological similarities:

1. Basidiomata with similar appearance, ochre brown-coloured, pubescent at the base.
2. Stipe surface formed by thin hyphae, slightly gelatinized, and with similar caulotrichomes.
3. Basal tomentum formed by scarcely septate, thick-walled hyphae
4. A slight hyaline zebra-like striped encrustation on the medulla hyphae.

Based on these similarities, *Macrotyphula fistulosa* and *T. phacorrhiza* appear to be closely allied species, as molecular phylogenetic inference also suggests (Pine et al. 1999, Dentinger & McLaughlin 2006, Hibbett 2007). Therefore, we reduce *Macrotyphula* to synonymy under *Typhula* to which we transfer several *Macrotyphula* species.

Specimens examined—**ANDORRA**. Pal, 31TCH7511, under *Pinus*, *Populus*, *Betula pendula*, and *Corylus avellana*, 15/X/2002, Olariaga, BIO-Fungi 12772. **FINLAND. etelä-Hame**: Mustiala, X/1867, P.A. Karsten, UPS F-124239 [as *Clavaria fistulosa*]. **LATVIA. baldone**: Kekava, Birzuli, ad terram, in alnetum glutinosae, 30/X/1955, A. Abolina, UPS F-552624 [as *Clavaria fistulosa*]. **SPAIN. León**: Puerto del Pontón, Riaño, 30TUN3677, 1000 m, branches of *Fagus sylvatica*, 01/X/2003, Olariaga, BIO-Fungi

9914. **MADRID**: Dehesa de Somosierra, 30TVL5153, 1500 m, buried remnants of *Corylus avellana*, 2/XI/2007, J.C. Zamora, BIO-Fungi 12611. **ASTURIAS**: Somiedo, 29TQH3373, 1150 m, among litter in acidophilous *Fagus sylvatica* forest, 27/X/2002, Olariaga, BIO-Fungi 9711. **SWEDEN**. **GÄSTRIKLAND**: Gävle, Lövudden, on fallen decaying log of *Alnus* (?), 10/XI/1957, R. Nannfeldt, UPS F-124234 [as *Clavaria contorta*]. **UPPLAND**: Vänge, Fiby urskog, S. Lundell n. 58l, 09/IX/1932, UPS F-124218 [as *Clavaria fistulosa*]. **VÄSTERGÖTLAND**: Töreboda, Gastorp, asplunden söder om Sommarhemmet, J. Lundberg 27/X/1955, UPS F-124212 [as *Clavaria fistulosa*]. **SWITZERLAND**. **VALAIS**: Mayoux, 30TVL5206, 1500 m, *Corylus avellana* branch, 31/VIII/2007, Felipe & Olariaga, BIO-Fungi 12610.

Typhula phacorrhiza (Reichard : Fr.) Fr., Observ. Mycol. 2: 298. 1818 : Fr., Syst. Mycol. 1: 495. 1821, as "*phacorrhiza*".

≡ *Clavaria phacorrhiza* Reichard : Fr., Schriften Berlin. Ges. Naturf. Freunde 1: 315. 1780.

≡ *Phacorhiza filiformis* Grev., Scott. Crypt. Fl. 2: 93. 1824.

LECTOTYPE (**designated here**): Sowerby, Col. Fig. Eng. Fung. 2: tab. 233. 1798, as "*phacorhiza*".

To our knowledge, the type species of *Typhula* has not previously been typified. We select a lectotype according to Articles 9.2 and 9.10 in the forthcoming "International Code of Nomenclature for algae, fungi, and plants (Melbourne Code)" (ICN 2012, in prep.). Fries (1821: 495) referred to the lectotype as "t. 253", a typographic error for t. 233. The sanctioned epithet spelling (Fries 1821) has been adopted, in agreement with the proposal by Demoulin (2010; subsequently ratified at the 18th International Botanical Congress, Melbourne, 2011).

SPECIMENS EXAMINED— **Without locality**, E. Coemans, [Rabenh. Fungi Eur. 418], UPS F-000023. **FRANCE**. **HAUTES PYRENÉES ATLANTIQUES**: near Candanchú, 30TYN0041, 1500 m, *Chaerophyllum aureum* leaves, 10/IX/2004, Olariaga, BIO-Fungi 10521. **SCOTLAND**. **FIFE**: Balmuto, 01/X/1822, Berkeley, E 218190 [as *Phacorhiza filiformis*]. **SWEDEN**. **VÄSTERGÖTLAND**: Göteborg, Stora Änggården, on decaying leaves, Sphagna etc. in a bog, T. Nathorst-Windahl, 29/IX/1937, [Lundell & Nannfeldt, Fungi Exs. Suec. 550], UPS F-011279. **SWITZERLAND**. **VALAIS**: Schwartzsee, bare soil under *Petasites*, *Chaerophyllum aureum* and *Cirsium*, 5/IX/2007, Felipe & Olariaga, BIO-Fungi 12618. **UNITED STATES OF AMERICA**. **NEW YORK**: Whetzel's garden, Fores Home, on buckwheat straw, 17/IV/1937, Remsberg, UPS F-552623.

Typhula tremula (Berthier) Olariaga, **comb. nov.**

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≡ *Macrotyphula tremula* Berthier, Bull. Mens. Soc. Linn. Lyon 43: 187. 1974.

Typhula tremula shares with *T. phacorrhiza* the characteristics explained above, as well as slender fruitbodies that make the two species appear very similar macroscopically.

SPECIMENS EXAMINED—**FRANCE**. **HAUTE-SAVOIE**: Hte. Savoie, Samoëns, les Saix, sur rachis d'*Athyrium filix-femina*, 08/IX/1965, G 110723, [Holotype, LY-Cl 14]. **SPAIN**. **LEÓN**: Soto de Sajambre. Vegabaño, 30TUN8187, 1500 m, dead remants of *Oreopteris*

limbosperma, Olariaga, 3/X/2004, BIO-Fungi 10727. **SORIA**: Laguna Negra, 30TWM1649, 1190 m, dead remnants of *Athyrium filix-femina*, Olariaga, 06/XI/2004, BIO-Fungi 10609. **SWEDEN**. **JÄMTLAND**: Tännäs socken, Svanskökläppen, 31SDE9209, stems of *Athyrium distentifolium*, Olariaga, 16/VIII/2006, BIO-Fungi 11702. **SWITZERLAND**. **BERN**: Grimselpass, 30TUN8187, 1500 m, on *Athyrium distentifolium* remnants, Olariaga, 02/IX/2007, BIO-Fungi 12609, BIO-Fungi 12699.

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A new species of *Stigmidium* (*Mycosphaerellaceae*) on *Aspicilia* from North America

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Abstract — *Stigmidium lendemeri* is described from North America on probably five species of *Aspicilia*. The new species belongs to the *Stigmidium placynthii* group in *Stigmidium* s. lato, distinguished from *Stigmidium* s. str. by long 3-to-5 celled periphysoids.

Key words — lichenicolous fungi, pseudoparaphyses, taxonomy

Introduction

Stigmidium Trevis. 1860 is a genus of predominately lichenicolous taxa comprising over ninety binominals (Mycobank 2012; Knudsen & Kocourková 2010; Kocourková & Knudsen 2009a; Pérez-Ortega et al. 2010) and currently included in *Mycosphaerellaceae* (Lumbsch & Huhndorf 2010). The type species is *S. schaereri* (A. Massal.) Trevis., a lichenicolous species occurring on sterile thalli of *Solorina* species (Roux & Triebel 1994; Crous et al. 2007). *Stigmidium* is heterogeneous (Calatayud & Triebel 2003; Kocourková & Knudsen 2009b). *Stigmidium* s. str. has perithecioid ascomata with external periphyses sensu Roux & Triebel 1994, short 2-celled periphysoids (pseudoparaphyses "Type a" sensu Roux & Triebel 1994), and 1-septate ascospores and lacks interascal filaments (Roux & Triebel 1994; Kocourková & Knudsen 2009b; Pérez-Ortega et al. 2010). *Stigmidium* s. str. comprises at least 24 species (Knudsen & Kocourková 2010; Etayo & Osorio 2004; Pérez-Ortega et al. 2010).

A distinct group in *Stigmidium* differs from *Stigmidium* s. str. in having long periphysoids of 3–5 cells (pseudoparaphyses "Type b" sensu Roux & Triebel 1994), no interascal filaments, and more or less well-developed external periphyses (Roux & Triebel 1994; Kocourková & Knudsen 2009b). This group currently comprises five species: *S. clauzadei* Cl. Roux & Nav.-Ros.

(Roux & Navarro-Rosinés 1994), *S. epistigmellum* (Nyl. ex Vouaux) Kocourk. & K. Knudsen (Kocourková & Knudsen 2009a), *S. hesperium* Kocourk. et al. (Kocourková & Knudsen 2009b), *S. placynthii* Cl. Roux & Nav.-Ros. (Roux & Triebel 1994), and *S. squamariae* (B. de Lesd.) Cl. Roux & Triebel (Roux & Triebel 1994, 2005). The long periphysoids are of diagnostic value but often hard to observe, apparently breaking off and dissolving when asci fill the ascomatal cavity in mature ascomata. Practically speaking, species with long periphysoids can be keyed out by host and ascospore size after they have been described.

In this paper we describe a sixth species of *Stigmidium* s. lato with long periphysoids from North America and found on several *Aspicilia* species.

Materials & methods

Specimens were supplied by the Cryptogamic Herbarium of the New York Botanical Garden (NY) and the Lichen Herbarium of the University of California at Riverside (UCR). Specimens have been examined using standard microscopical techniques. Hand-made sections were studied in water and 10% KOH [K] and lactophenol cotton blue [LPB]. Amyloid reactions were tested in Lugol's iodine 1% with and without pre-treatment with 5% KOH [K/I]. Metachromatic reactions were tested with 1% solution of brilliant cresyl blue [BCr]. Ascospore measurements were made in water with accuracy of 0.5 µm and given in the form "(minimum–) mean minus standard deviation–**mean**–mean plus standard deviation (–maximum)" and followed by the number of measurements (n); the length/breadth ratio of ascospore is indicated as l/b and given in the same form.

Macro and microphotographs were taken with a digital camera Olympus DP72 on Olympus SZX 7 Stereomicroscope and Olympus BX 51 fitted with a Nomarski differential interference contrast.

The species

Stigmidium lendemeri Kocourk. & K. Knudsen, **sp. nov.** PLATE 1 & 2

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Differs from other members of the *Stigmidium placynthii* group by its larger ascospores and its *Aspicilia* hosts.

TYPE: U.S.A. Pennsylvania. Lackawanna Co., Moosic Mountains, Montage Heath Barrens, sandstone and conglomerate outcrops on west slope, 41°21′05″N 75°40′18″W, 396–426 m, on *Aspicilia* species, Sept. 30, 2005, Lendemer 5544 w/ Schuyler (NY, **holotype**).

ETYMOLOGY: The species is named for the North American lichenologist James C. Lendemer (NY), who brought the taxon to our attention, in honor of his work on the lichen biota of North America, on *Lepraria*, and on the journal OPUSCULA PHILOLICHENUM. We value him as both a colleague and good friend.

INFECTION not visible. MYCELIAL HYPHAE not observed. ASCOMATA perithecioid, black, globose to subglobose, ostiolate, 60–100(–120) µm high and 60–100(–120) µm wide, partially immersed in the host areoles, usually dispersed, one

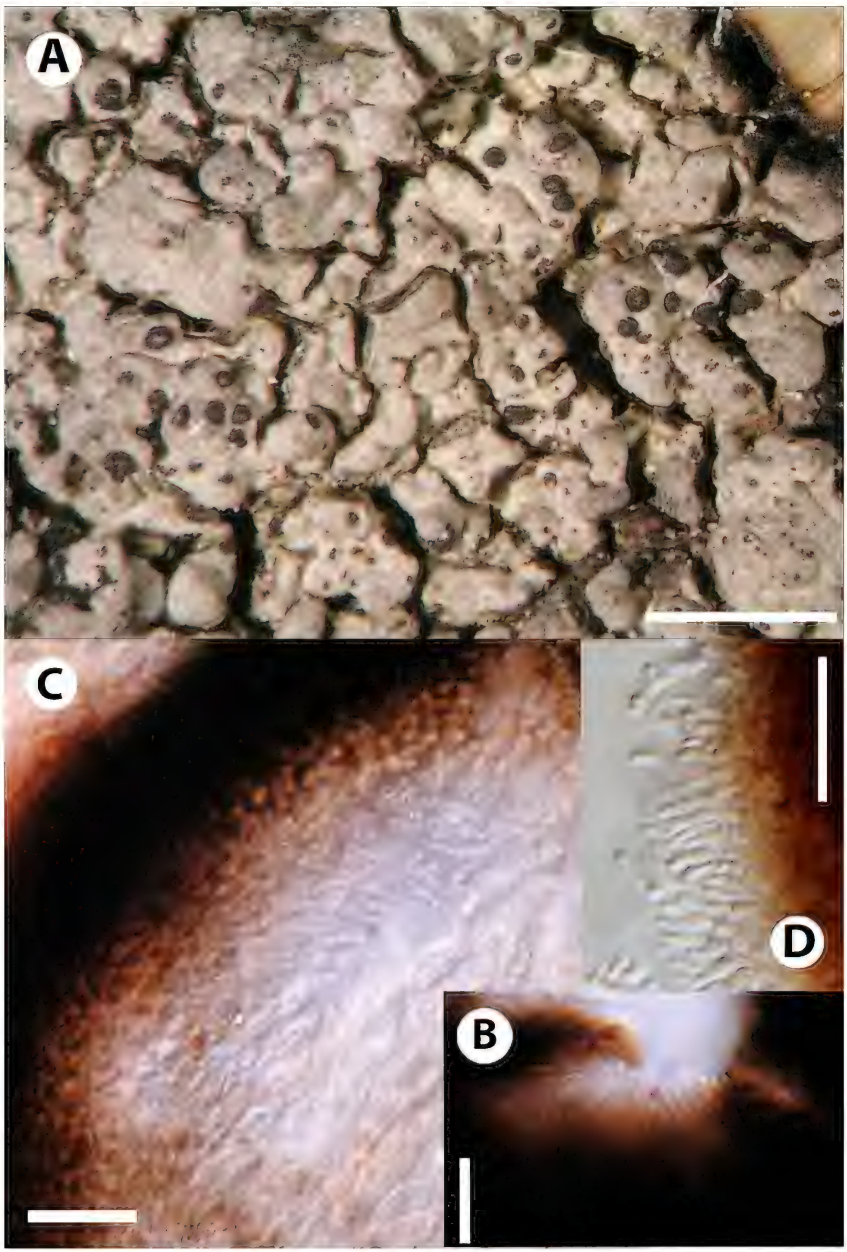


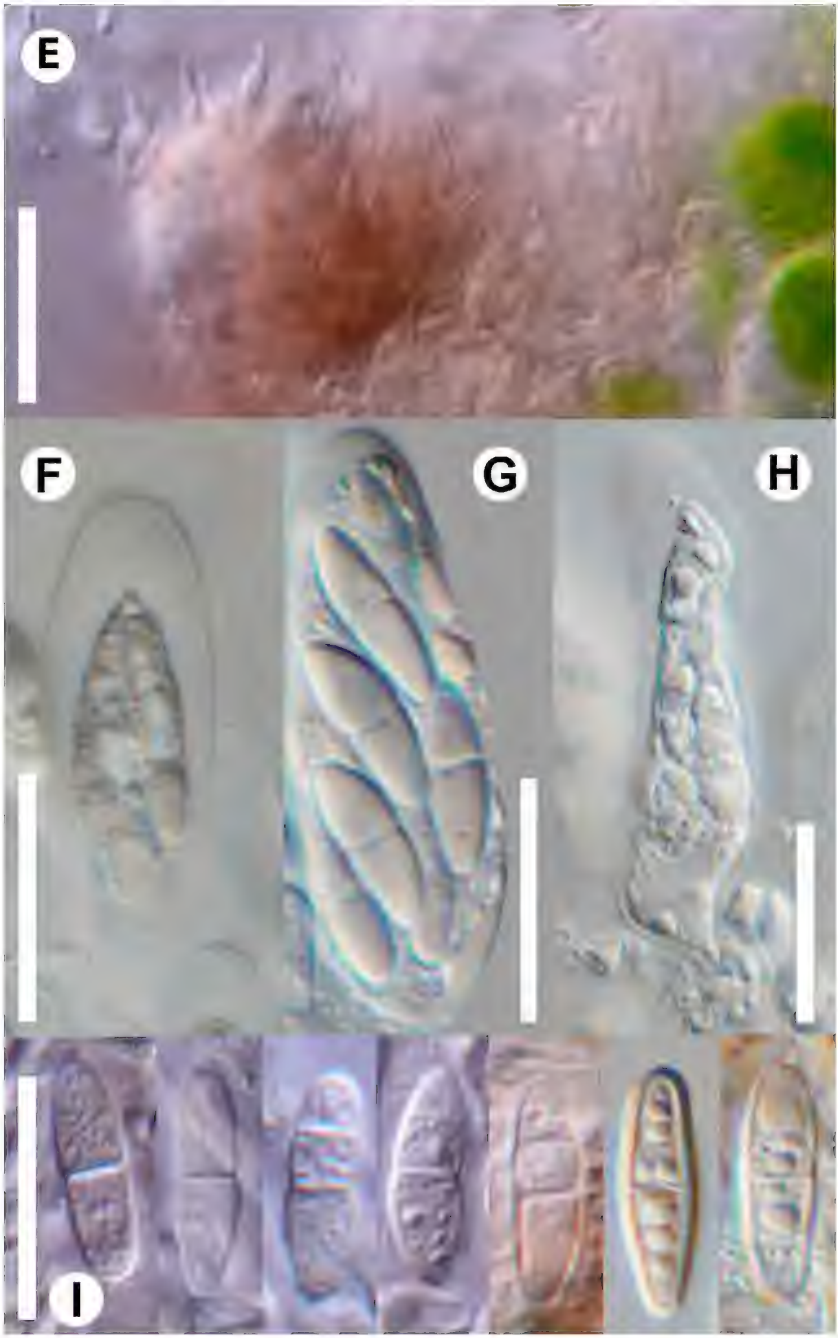
Plate 1. Figs A–D. *Stigmidium lendemeri* (Lendemer 5544, holotype). A, Infected thallus of *Aspicilia* sp. B, Ostiole with fringe of external periphyses. C, D Ascomatal section with pendent periphyses (pseudoparaphyses "Type b"). Scale bars: A = 1 mm; B–D = 20 µm.

or two per areole, causing no visible sign of infection but infected areoles not usually producing apothecia. Exciple dark brownish-black in upper 1/5–1/3, lighter brown or reddish brown in lower 4/5–2/3, but still dark even in thin sections, never hyaline, 10–15 µm thick in optical section, often thickest (up to 15 µm) in ostiolar area, of 2–4 compressed cell layers, textura angularis, cells mostly 4–9 × 3.5–4 µm in optical section, I–, BCr–. External periphyses visible as a dense fringe when viewed from above in mature ascomata, derived from ascomatal wall, 8–14 µm long, brown at base to pale yellowish-brown or almost hyaline at tip, mostly 1–1.5 µm wide, septate, cells 3–5 µm long, comprised of 2 to 3 cells, the base cell usually widest. Hamathecium of pendant periphysoids (pseudoparaphyses "Type b") originating from the upper wall of ascomatal cavity, hyaline, rarely branching, 12–15(–20) µm long, mostly 2 µm wide, septate, formed of 3 or more cells, cells 3–5 µm long, uneven in length. Lacking interascal filaments. Hymenial gel I–, K/I–, BCr+ light violet. Asci originating from lower wall of ascomatal cavity, fissitunicate, narrowly saccate, endoascus thickened in upper 1/3, sessile to stipitate, 8-spored, with ascospores distichously arranged, 20–30 × 10–12(–15) µm, I–, ascoplasma I+ red, exoascus BCr–, endoascus BCr+ blue-violet. Ascospores 1–septate, hyaline, brownish when over-mature and with 1 pseudoseptum (possibly also pseudotetrablastic but not seen), non-halonate, not constricted at septa, when 2-celled, cells usually equal in length, (14.0–)15.5–**17.3**–19.0(–21.0) × (4.0–)5.0–**5.8**–6.5(–7.0) µm (n = 40), l/b = (2.3–)2.6–**3.0**–3.4(–4.5); epispore BCr+ dark blue; perispore BCr+ very pale violet. Conidiomata 30–45 µm in diam., conidiogenous cells ampuliform 4.5–5.0 high, 4.0–4.5 µm wide, conidia cylindrical, strait or slightly curved, 4.5–6.0 × 1.0–1.5 µm.

Substrate and ecology — On probably five different *Aspicilia* species with stictic or norstictic acid or lacking extrolites that typically occur on non-calcareous rocks in open habitats (talus slopes, glades, rock ledges) with constant high humidity and on boulders in or near rivers or streams. We are unsure of the exact *Aspicilia* species in many cases as the genus is in need of revision. In a few cases the lack of conidia precluded accurate identification of the host.

Distribution — North America (California, Missouri, Ohio, Pennsylvania). Because it is host specific on genus level on multiple species we expect more reports from throughout North America. A taxon with similar ascospores causing a black infection was seen from California (UCR) and Kansas (NY) and needs further study.

Plate 2. Figs E–I. *Stigmidium lendemeri* (Lendemer 5544, holotype). E. Pycnidium, conidiogenous cells and conidia. F. Young ascus with apical typically short beak. G. Ascus with ascospores. H. Ascus releasing content. I. Nearly mature and mature ascospores. Scale bars: 20 µm.


E
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Selected specimens examined — **U.S.A. California.** Mariposa Co., Sierra Nevada Mountains, Yosemite National Park, Merced River near Highway 140, 37°40′19″N 119°47′32″W, 653 m, on *Aspicilia* species (no extrolites) on boulders in river, Sept. 20, 2009, Knudsen 11680 (UCR); Tuolumne Co., Sierra Nevada Mountains, Yosemite National Park, Inspiration Point along Hetch Hetchy Road, Poopanaut, 37°54′12″N 119°50′01″W, 1601 m, on *Aspicilia* species (no extrolites), Sept. 19, 2009, Oregon State University Survey, Knudsen 11556 (UCR); **Missouri.** Iron Co., Ketcherside Mountain Conservation Area, Royal Gorge Nature Area, Big Creek, 37°32′21″N 90°41′01″W, on sterile *Aspicilia* species (stictic acid), March 26, 2006, Buck 49747 (UCR); Shannon Co., Ozark National Scenic Riverways, Rocky Creek, mesic forest, 37°07′N 91°12′W, 200–215 m, on *Aspicilia* species (norstictic acid) on rhyolite, April 16, 1997, Buck 31872 (NY); Wayne Co., Sam A. Baker State Park, Mudlick Mountains, 37°15′27″N 90°31′23″W, 300 m, on *Aspicilia* species (stictic acid), Oct. 15, 2003, Buck 45324 (NY); Washington Co., Mark Twain National Forest, Little Pilot Knob, 37°58′57″N 90°58′40″W, on *Aspicilia* species (stictic acid), May 24, 2003, Harris 47935 (NY); **Ohio.** Scioto Co., along Pond Lick Run, Shawnee State Forest, sandstone outcrops along stream in oak woodland, 38°42′20″N 83°08′25″W, 198–213m, on *Aspicilia* species, May 21, 2006, Lendemer 7175 (NY); **Pennsylvania.** Bedford Co., Pleasant Valley, Buchanan State Forest, west-facing slope with granite and sandstone boulders, 40°03′18″N 78°30′43″W, 518–548 m, on sandstone, on *Aspicilia* species, May 18, 2006, Lendemer 7294 (NY); Berks Co., west slope of Mt. Pleasant, French Creek State Park, 40°11′33″N 75°47′10″W, 213–243 m, on *Aspicilia* species, Nov. 19, 2006, Lendemer 8036 (NY); Bucks Co., Ringing Rock County Park, diabase boulder field along stream, 40°33′43″N 75°07′42″W, 137–152 m, on *Aspicilia* species, Sept. 15, 2005, Lendemer 4982 w/ Schulyer (NY); Carbon Canyon, east shore of Leigh River, Leigh Gorge State Park, cliff along railroad track, 40°57′58″N 75°42′22″W, 304 m, on cliff, on *Aspicilia* cf. *laevata*, Nov. 9, 2003, Lendemer 1491 w/ Rhoads (NY).

Discussion

The presence of long periphysoids with 3 or more cells places *Stigmidium lendemeri* in the *S. placynthii* group (Roux & Triebel 1994) in which we currently recognize five other species. "The small differences in ascospores size are assumed to be an important morphological expression of phylogenetic distance." (Kocourková & Knudsen 2009b). These small differences (compared with *S. lendemeri*) are summarized below, but in addition all differ in the host genera and species infected.

(1) *Stigmidium placynthii* on *Placynthium nigrum* has smaller halonate ascospores, (7.5–)9.5–**11.1**–12(–13.5) × 3.0–**3.3**–3.5(–4.0) µm.

(2) *Stigmidium epistigmellum* on maritime *Caloplaca* species has narrower ascospores, (14.5–)15.8–**17.5**–19.1(–21.5) × (3.5–)3.9–**4.2**–4.7(–5.0) µm.

(3) *Stigmidium squamariae* on several *Lecanora* and *Rhizoplaca* species has shorter halonate and constantly hyaline ascospores, (8.5–)9–**10.9**–12.5(–14) × (4–)5–**5.3**–5.5(–6) µm, and lacks reactions with BCr.

(4) *Stigmidium clauzadei* on *Verrucaria nigrescens* and *V. viridula* has generally shorter and wider 1-septate hyaline and halonate

ascospores, (10)–12.5–**15.1**–19 × (4.5)5–**5.5**–6.5(–7.5) µm,
and all parts BCr– except perispore BCr+ pale blue.

(5) *Stigmidium hesperium* on *Caloplaca* species has shorter and narrower ascospores, (12.5–)13.0–**13.75**–14.5(–15.5) × (3.5–)4.0–**4.5**–5.0(–5.5) µm.

The only *Stigmidium* previously reported on *Aspicilia* is *Stigmidium aggregatum* [= *Pharcidia aspiciliae*] on *Circinaria calcarea* [≡ *Aspicilia calcarea*], which has much larger ascospores, 22–30 × 4.5–9 µm and is apparently known only from two lost types (Kocourková & Knudsen 2010). Based on our study of the problem, *S. aggregatum* may not even be a *Stigmidium*.

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Notes on some Eurasian species of *Anthracoidea* and *Entyloma*

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Abstract — New records of smut fungi representing *Anthracoidea* and *Entyloma* from Israel, Belarus, Kyrgyzstan, and Russia are presented. Each record is followed by a comprehensive description and illustrations based on original material. Additionally, a revision of *Entyloma*/*Ranunculus* records from Israel is given.

Key words — *Anthracoideaceae*, biodiversity, *Entylomatales*, Middle East

Introduction

Five new records of *Anthracoidea* species are reported, three for Belarus, one for Kyrgyzstan, and one for Russia; and three new records of *Entyloma* species, one new for Belarus and two for Israel. In addition, records of *Entyloma* on *Ranunculus* in Israel are revised.

Materials & methods

Sorus and spore characteristics were studied using dried herbarium material. The specimens were examined by light microscopy (LM) and scanning electron microscopy (SEM).

The sorus structure was studied under a Carl Zeiss Stemi Dv4 stereo microscope. For light microscopy (LM), spores were mounted in lactic acid, gently heated to the boiling point and cooled, and then examined at 1000× under a Carl Zeiss Axiostar light microscope. LM photographs were taken with a Canon Power Shot G10 camera. At least 50 spores were measured from each collection, and the variation is presented as a range, with extreme values given in parentheses. In the descriptions, mean and standard deviations (SD) calculated from spores measured in all specimens are listed after spore size ranges. For scanning electron microscopy (SEM), spores were attached to metal stubs by double-sided adhesive tape and coated with gold. The surface structure of spores was

observed at 15 kV and photographed with a scanning electron microscope JEOL JSM-6700F. Specimens used in this study are stored in the Herbarium of Haifa University (HAI), Herbarium of the Hebrew University of Jerusalem (HUJ), National Herbarium of Ukraine (KW), and HeKS, a personal, working collection of Kyrylo Savchenko.

Taxonomy

Anthracoidea angulata (Syd.) Boidol & Poelt, Ber. Bayer. Bot. Ges. 36: 23 (1963) Figs. 1–2

Sori in the ovaries of the inflorescences, forming black, globose, subglobose bodies around the achenes, 2–3 µm in diameter, dusty on the surface. Spores medium-sized, flattened, medium reddish brown, angular, irregular, elongated, (15–)17–20(–22) × 13–19(–20) µm [av. ± SD, 18 ± 1.5 × 16.5 ± 2 µm]. Spore wall evenly to unevenly thickened, ca. 1.2–2.5 µm thick, thickest at the angles, usually with several protuberances, light refractive spots and internal swellings; surface finely verruculose with densely situated, rounded warts. Spore profile wavy.

Distribution: Europe, Asia.

Specimens examined: **BELARUS**. Minsk region, Minsk district, near Volchkovichi, oak-grove, 20.VII.2005, on *Carex hirta* L., leg. I.S. Hirylovich (HAI 2864, HeKS 223); Smolevichi district, forest near Zhazhelka, 25.VII.2005, on *C. hirta*, leg. I.S. Hirylovich (HAI 2865). Mogilev region, Osipovichi district, near Daraganovo, on the railway embankment, on *C. hirta*, 18.VIII.2010, leg. I.S. Hirylovich (HAI 2866).

Note: *Anthracoidea angulata* is a new species for the Belarusian mycobiota.

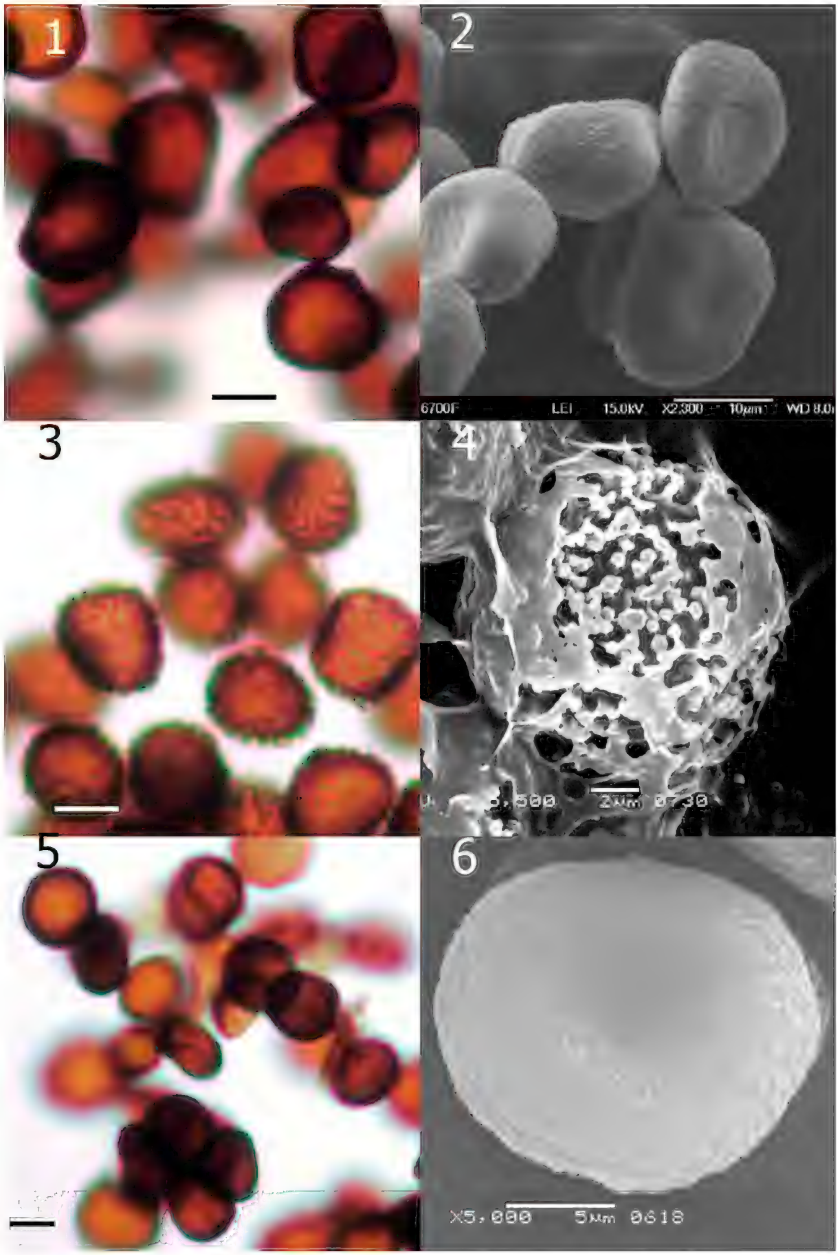
Anthracoidea echinospora (Lehtola) Kukkonen, Ann. bot. Soc. Zool.-Bot. fenn. 'Vanamo' 34(3): 72 (1963) Figs. 3–4

Sori in the ovaries of the inflorescences, forming carbonaceous, globose, subglobose bodies around the achenes, 2–3 µm in diameter, covered by a thin silvery-greyish membrane; during maturation the spore mass cracks down. Spores small, flattened, olivaceous-brown to brown, subglobose, ovoid, irregular, sometimes elongated, (12–)13–20(–22) × (11–)12–15(–17) µm [av. ± SD, 16 ± 2.5 × 13.4 ± 2.1 µm]. Spore wall evenly thickened, ca. 1 µm, without any light refractive spots or internal swellings; surface echinate with irregularly dispersed, apically enlarged and flattened, often confluent spines ≤ 1.5 µm high. The wall between the spines striate-rugulose; the base of the warts longitudinally crumpled. On the tips of the warts the remnants of a thin membrane cover some parts of the spore surface.

Distribution: Europe, Asia.

Specimen examined: **BELARUS**. Gomel region, Zhlobin district, near Zhlobin, on *Carex acuta* L., 18.VII.2009, leg. I.S. Hirylovich (HAI 2867, HeKS 224).

Note. *Anthracoidea echinospora* is a new species for the Belarusian mycobiota.



Figs 1–6. **1–2**: spores of *Anthracoidea angulata* on *Carex hirta*. **3–4**: spores of *A. echinospora* on *C. acuta*. **5–6**: spores of *A. heterospora* on *C. nigra*. 1,3,5 = LM; 2, 4,6 = SEM. Scale bars: 1–3, 5 = 10 μm; 4 = 2 μm; 6 = 5 μm.

Anthracoidea elynae (Syd.) Kukkonen, Ann. bot. Soc. Zool.-Bot. fenn. 'Vanamo' 34(3): 65 (1963) FIGS. 7–9

SORI in the ovaries of the inflorescences, forming black, globose, hard bodies around the achenes, 1.5–2.5 mm in diameter, dusty on the surface, partly hidden by the perigynium. SPORES medium-sized, flattened, medium to dark reddish brown, subglobose, disc-shaped, (15–)16.5–19.5(–20.5) × (13–)14–18(–19) µm [av. ± SD, 18.2 ± 1.6 × 15.9 ± 2.2 µm]. Hyaline sheaths on the flat sides of the spores present. SPORE WALL evenly thickened, ca. 1–2 µm thick, thickest at the angles, no light-refractive areas, internal swellings were not observed; surface almost smooth to finely verruculose on the flat side. Spore profile smooth.

DISTRIBUTION: Europe, Asia, North America.

SPECIMENS EXAMINED: **KYRGYZSTAN**. Issyk Kul Province, Ak-Suu district, near Karakol, on *Kobresia capillifolia* (Decne.) C.B. Clarke, 5.VIII.1933, leg. M.V. Klokov (KW 37520).

NOTE. *Anthracoidea elynae* is a new species for Kyrgyzstan.

Anthracoidea heterospora (B. Lindeb.) Kukkonen, Ann. bot. Soc. Zool.-Bot. fenn. 'Vanamo' 34(3): 63 (1963) FIGS. 5–6

SORI in the ovaries of the inflorescences, forming black, globose, subglobose to ovoid bodies, 1–3 mm in diameter, powdery on the surface. SPORES small, flattened, medium reddish brown, globose, subglobose, angular, (10–)12–19 (–21) × (10–)11–17 µm [av. ± SD, 16 ± 2.5 × 13.2 ± 2.1 µm]. SPORE WALL ca. 1–2 µm thick, thickest at the angles, usually with several internal swellings; surface finely and densely verruculose with densely situated, rounded, often confluent low warts. Spore profile slightly wavy.

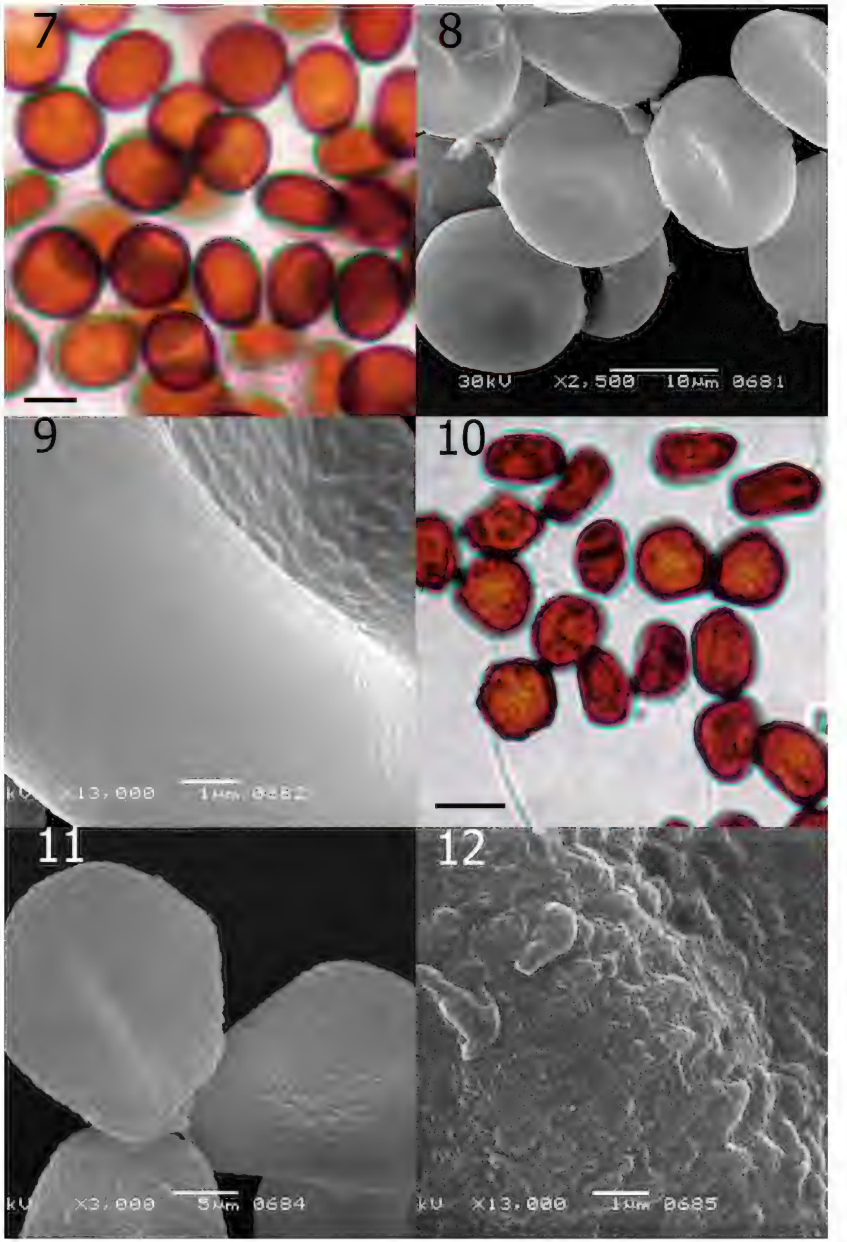
DISTRIBUTION: Europe, Asia.

SPECIMENS EXAMINED: **BELARUS**. Minsk region, Minsk district, near Zacep, 27.VII.2008, on *Carex nigra* (L.) Reichard, leg. I.S. Hirylovich (HAI 2871); Valozhyn district, near Krazhino, on the forest edge, on *C. nigra*, 22.VI.2005, leg. I.S. Hirylovich (HAI 2868, HeKS 225).

NOTE. *Anthracoidea heterospora* is a new species for the Belarusian mycobiota.

Anthracoidea tomentosae Vánky, Bot. Not. 132: 227 (1979) FIGS. 10–12

SORI in the ovaries of the inflorescences, forming black, globose, subglobose, hard bodies around the achenes, 1–2 mm in diameter, when young covered by a white-silvery membrane; spore mass agglutinated to semi-agglutinated, partly hidden by the perigynium. SPORES large, flattened, medium to dark reddish brown, subglobose, sub-angular, irregular, (19–)21–27(–28) × (14–)15.5–22(–24) µm [av. ± SD, 23.5 ± 2.3 × 18.1 ± 2.6 µm]. SPORE WALL unevenly thickened, ca. 1.5–2.5(–3.5) µm wide, thickest at the angles, usually with several protuberances, light refractive spots and internal swellings sometimes present; surface finely punctate-verruculose with densely situated,



Figs 7–12. **7–8**: spores of *Anthracoidea elynae* on *Kobresia capilliformis*. **9**: spore surface of *A. elynae* on *K. capilliformis*. **10–11**: spores of *A. tomentosae* on *Carex tomentosa*. **12**: spore surface of *A. tomentosae* on *C. tomentosa*. 7, 10 = LM; 8, 9, 11, 12 = SEM. Scale bars: 7, 8, 10 = 10 µm; 9, 12 = 1 µm; 11 = 5 µm.

often confluent, 0.2–0.5 µm high, rounded warts. The spaces between the warts minutely verruculose. Spore profile serrulate.

Distribution: Europe, Asia.

Specimen examined: **RUSSIA**. Krasnodar Krai, Gelendzhik district, near Kabardinka, on *Carex tomentosa* L., 15.VI.1986, leg. N. Chernov (KW 37611).

Note. *Anthracoidea tomentosae* is a new species for the Russian mycobiota.

Entyloma ficariae A.A. Fisch. Waldh., Bull. Soc. nat. Moscou, Biol. 52: 309 (1877) Figs. 13–15

Sori (Fig. 13) in leaves as flat, round, or angular spots, 2–7 mm in diameter, first white, later pale creamy-brown. Spores (Figs. 14–15) globose, subglobose, ovoid, (11–)12–15(–16) × (9–)10–13(–15) µm [av. ± SD, 14 ± 2.1 × 11 ± 1.8 µm], subhyaline. Spore wall even, smooth, ca. 1–2.5 µm thick. Anamorph present on both sides of leaves.

Distribution: Europe, Asia, Africa.

Specimen examined: **ISRAEL**. Golan Heights, Hermon National Park, 400 m northeast from Neve Ativ, 1180 m. alt., 32°26′45″N 35°74′83″E, on *Ranunculus ficaria* L., 26.IV.2011, leg. K.G. Savchenko (HAI 2863, HeKS 228; GenBank JQ586199).

Note. *Entyloma ficariae* is a new species for the Israeli mycobiota.

The closely related *E. majewskii* Vánky & M. Lutz is also distributed in the Irano-Turanian floristic region, particularly in Iran, but differs from *E. ficariae* by thicker spore walls (≤ 7 µm), the absence of the anamorph, and bullate rather than flattened sori (Vánky & Lutz 2010). Molecular analyses confirmed the assignment of the specimen from Mount Hermon to *E. ficariae*.

Entyloma gaillardianum Vánky, Mycotaxon 16: 104 (1982) Figs. 19–21

Sori in leaves, as rounded, circular spots, 1–5 mm in diameter, or larger by confluence, first pale yellowish-green, later brownish-green, with a thin yellowish margin around the spots. Spores globose, subglobose, irregular, subhyaline to lemon yellow, 10–14 × 9–13(–14) µm [av. ± SD, 12.5 ± 1.6 × 11.4 ± 1.4 µm]. Spore wall 2-layered, ca. 1–3 µm. Spore surface smooth.

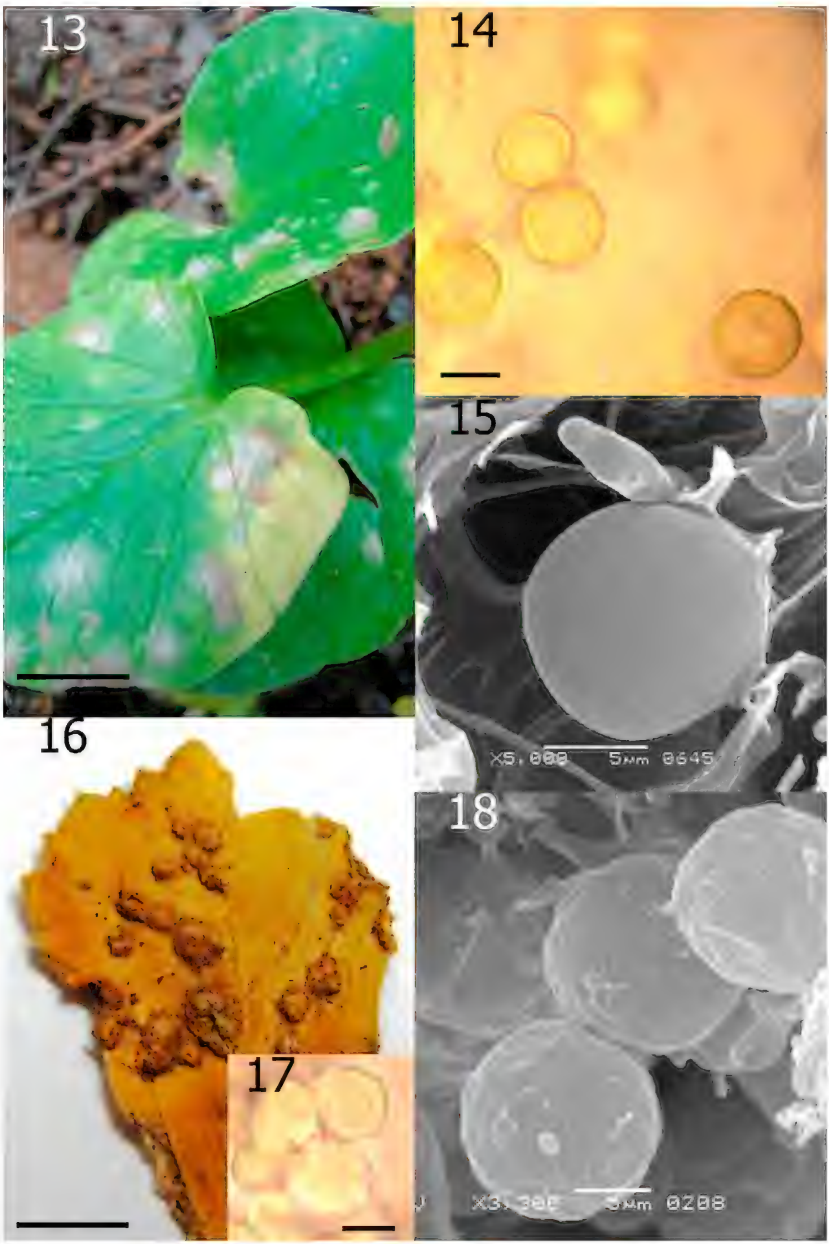
Distribution: worldwide.

Specimen examined: **ISRAEL**. Upper Jordan Valley, Tiberias, 20.IV.2005, on cultivated *Gaillardia aristata* Pursh, leg. S. Voytyuk (HAI 2869, HeKS 229).

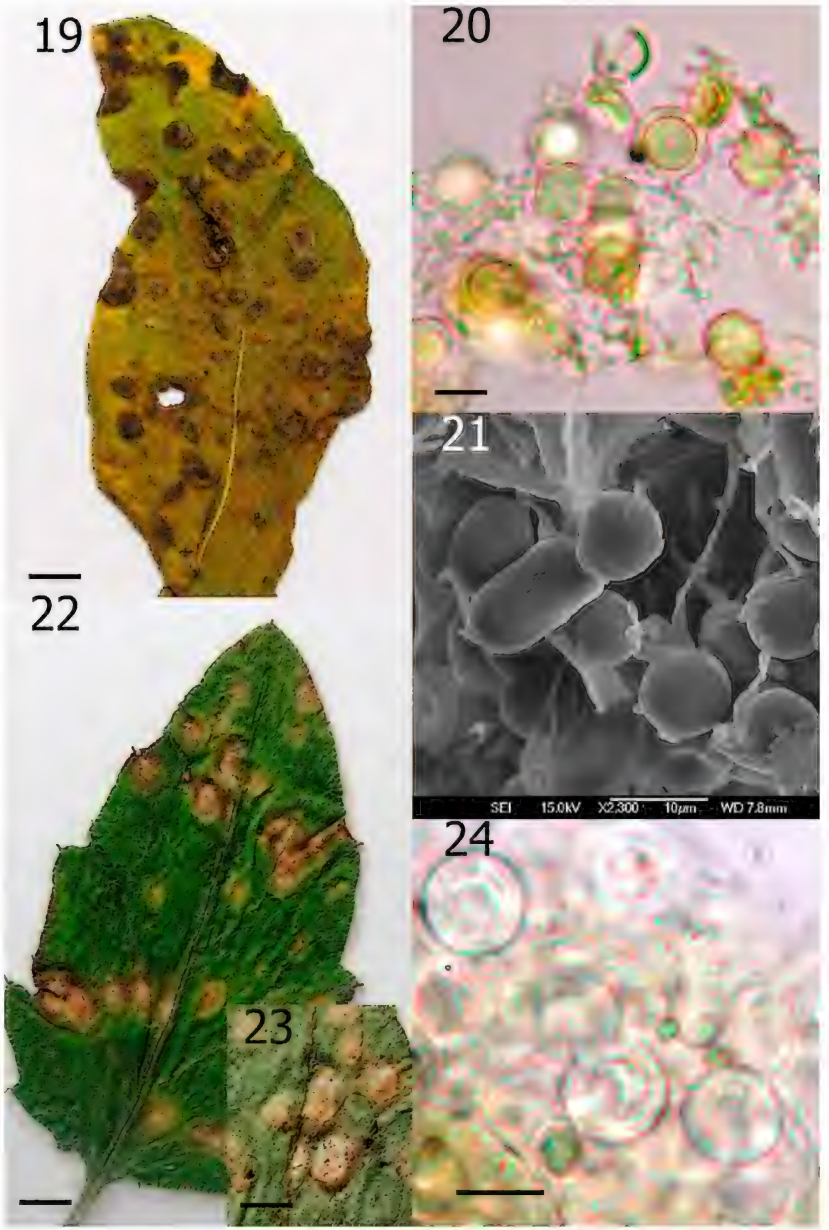
Note. *Entyloma gaillardianum* is new for the Israeli mycobiota and probably was imported into the country with *Gaillardia* plants.

Entyloma hieracii Syd. & P. Syd. ex Cif., Bull. Soc. Bot. Ital. 1924: 50 (1924) Figs. 22–24

Sori in leaves, as rounded, angular spots, 1–7 mm in diameter, first pale yellowish-white, later yellowish-brown, with a thin pale green margin around



Figs 13–18. **13**: sori of *Entyloma ficariae* on *Ranunculus ficaria*. **14–15**: spores of *E. ficariae* on *R. ficaria*. **16**: sori of *E. microsporum* on *Ranunculus asiaticus*. **17–18**: spores of *E. microsporum* on *R. asiaticus*. 14, 17 = LM; 15, 18 = SEM. Scale bars: 13, 16 = 5 mm; 2, 3, 5, 6 = 5 μm.



Figs 19–24. **19**: sori of *Entyloma gaillardianum* on *Gaillardia aristata*. **20–21**: spores of *E. gaillardianum* on *G. aristata*. **22–23**: sori of *E. hieracii* on *Hieracium sylvularum*, adaxial and abaxial sides respectively. **24**: spores of *E. hieracii* on *H. sylvularum*. 20, 24 = LM; 21 = SEM. Scale bars: 19 = 10 μm; 20, 21, 24 = 10 μm; 22 = 4 mm; 23 = 3 mm.

the spots. Spores globose, subglobose, irregular, sub-hyaline to yellow, (9–) 10–15(–16) × 8–12(–14) µm [av. ± SD, 12.3 ± 2.5 × 9.9 ± 1.9 µm]. Spore wall even, ca. 1–3 µm wide. Spore surface smooth.

Distribution: Europe, Asia, North America.

Specimen examined: **BELARUS**. Minsk region, Minsk district, near Volchkovichi, oak-grove, on *Hieracium sylvularum* Boreau, 20.VII.2005, leg. I.S. Hirylovich (HAI 2870, HeKS 230).

Note. *Entyloma hieracii* is a new smut fungus for the Belarusian mycobiota, and *H. sylvularum* is a new host for this species.

Entyloma microsporum (Unger) J. Schröt., in Rabenhorst, Fungi Europ. Exsicc. no. 1872 (1874) Figs. 16–18

Sori in leaves, as wart-like swellings, different in shape, 1–5 mm in diameter, first yellowish-white, when dry adaxially brownish, abaxially ocher-brown, swollen, with cracked surface. Spores densely situated, globose, subglobose, irregular, subhyaline to light yellowish, (12–) 14–19(–21) × (10–)12–17(–18) µm [av. ± SD, 16 ± 2.1 ×15 ± 1.8 µm], with granular matrix. Spore wall 2-layered, with yellow, even, ca. 0.5 µm thick inner layer, and hyaline, uneven, ca. 1–6 µm thick outer layer. Spore surface smooth, often covered by separated remnants of spore walls.

Distribution: worldwide.

Specimens examined: **ISRAEL**. Samaria, Wadi Fedjaz, 24.II.1957, on *Ranunculus asiaticus* L., leg. A. Grizi (HUJ); Upper Galilee, Mount Meron (= Mount Jermak), on *R. asiaticus*, 27.II.1951, leg. C. Rayss (HUJ, as *E. ranunculorum*).

Note. This taxon has previously been recorded from Israel under the names *Entyloma microsporum* and "E. *ranunculorum*" (Rayss 1952, 1959; Savchenko et al. 2010). Although the invalid name "*E. ranunculorum*" Liro is usually equated with E. *ranunculi-repentis* Sternon (Vánky 2011: 201–202), accurate microscopical examination of soral structure and spore morphology indicated that the Mount Meron collection should be assigned to *E. microsporum*. The Mount Meron collection has smaller spores [(12–)12.5–17(–18) × (10.5–) 11–16(–17) µm] with thinner walls [1.5–5 µm], compared with the Samaria collection [(13–)13.5–19.5(–21) × (11–)13–17.5(–18) µm, with 2.5–6 µm walls].

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Lactarius annulocystidiatus sp. nov. from India

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Abstract — *Lactarius annulocystidiatus*, a new species of subgenus *Tristes*, is found associated with *Quercus leucotrichophora*. It is characterized by its granular pleurocystidia, with granulations clustered in annular rings around the cystidial tips. Macro- and microscopic features and data on ecological distribution are presented.

Key words — ectomycorrhizal, macrofungi, *Russulaceae*, taxonomy

Introduction

Lactarius Pers. is an agaricoid member of family *Russulaceae*, represented by 450 species worldwide (Kirk et al. 2008) and approximately 71 taxa from India (Atri et al. 1994, Natarajan et al. 2005, Das & Sharma 2005). The macroscopic and microscopic characters of a collection from Himachal Pradesh were compared with previously described species (Pearson 1950, Hesler & Smith 1979, Eberhardt & Verbeken 2004, Das et al. 2004, Das & Sharma 2005, Buyck et al. 2007, Le et al. 2007, Wang 2007, Stubbe et al. 2008, Montoya & Bandala 2008, Stubbe et al. 2010, Das & Verbeken 2011, 2012) and found to be sufficiently different to warrant description as a new species.

Material & methods

The macromorphology of the examined collection recorded on gross external morphology and micromorphology was studied in accordance to the methodology given by Atri et al. (2005). The terminology used for describing the color tone of the carpophore parts and spore print is after Kornerup and Wanscher (1978). Microscopic line drawings were made with the aid of a camera lucida at 1000×. Basidiospore measurement excludes the height of ornamentation and length of apiculus. Basidium length excludes the length of sterigmata. The spore shape quotient (Q=L/W) was calculated considering the mean value of length and width of 20 basidiospores. The holotype specimen has been deposited in the Herbarium of Botany Department (PUN), Punjabi University.

Taxonomy

Lactarius annulocystidiatus S. Sharma, M. Kaur & Atri **sp. nov.** FIGS 1–6

MYCOBANK MB 562761

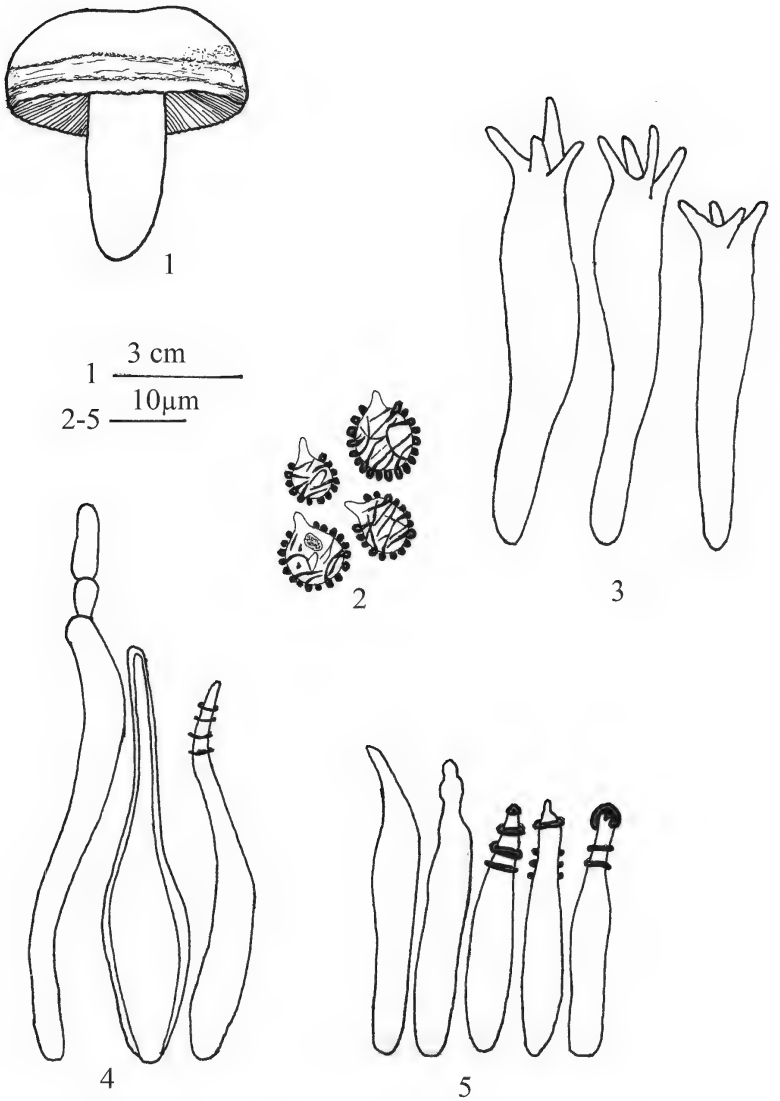
Differs from *Lactarius argillaceifolius* by its smaller basidiospores and smaller pleurocystidia with granulations in annular rings towards the tips.

TYPE: India, Himachal Pradesh: Andretta, solitary carpophore on humicolous soil in association with *Quercus leucotrichophora* A. Camus *(Fagaceae)*, 31 August 2009, Samidha 4314 (PUN, **holotype**)

ETYMOLOGY: The species epithet is based on the presence of granulations in an annular pattern around the cystidial tips.

Fructification ≤ 6.5 cm in height. Pileus ≤ 6 cm broad, convex, feebly zoned concentrically around the periphery, shiny viscid; margin regular, unbearded; surface light yellow ($4A_4$), olivaceous to spotted pinkish to reddish brown; viscid; apex depressed; surface browning on bruising. Latex grayish milky, unchanging, mild; cuticle not peeling; flesh ≤ 0.2 cm broad, light yellow ($4A_4$), brownish on exposure, mild. Lamellae adnexed, unequal, crowded, light yellow ($4A_4$), brownish on bruising, narrow (0.3 cm broad), edges smooth, fragile. Taste mild, odour fruity. Stipe central, 4 cm long, 2 cm broad above and 1.2 cm broad below, tapering downwards, concolorous with the pileus, slimy viscid, brownish on bruising, hollow, smooth.

Basidiospores 5.7–8.6 × 5.7–7.2 µm, globose to broadly ellipsoidal (Q = 1.0–1.2), warty, warts ≤ 1.4 µm high, strongly amyloid, ornamentation in the form of coarse banded ridges forming incomplete reticulation and some warts isolated, at places 2–3 warts connected, ornamentation type I, IIIb, IV, VI (sensu Singer, 1986), plage amyloid and distinct, apiculate; apiculus ≤ 1.4 µm long. Basidia 40–50 × 5.7–8.6 µm, 4-spored, clavate, hyaline to densely granular, 6 basidia/100 µm, abundant, sterigmata 2.9–7.2 µm long. Pleurocystidia: macrocystidia 43–71.5 × 5.7– 11.4 µm, granular, thick walled, clavate, fusoid to ventricose in shape with moniliform, flame–shaped, capitate to mucronate or tubular pointed tips, granulated with granular contents aggregated in rings mostly towards the tips, which are prominently present around and near the gill edges; pseudocystidia 57.2–65.8 × 5.7–7.2 µm, vermiform, deeply seated, not projecting beyond basidia. Cheilocystidia 32.9–38.6 × 5.7–7.2 µm, similar in details to pleurocystidia. Hymenophoral trama hyphal, irregularly arranged, subhymenium indistinct. Pileus cuticle 150–200 µm thick, partially gelatinized, made up of horizontally running, branched closely septate 4.3– 5.7 µm broad hyphae, some ampulliform, some H-shaped with rectangular cells; pilear trama made up of rosettes of sphaerocysts intermingled with ≤ 5.7 µm broad hyphae and laticifers. Stipe cuticle gelatinized, made up of longitudinally running ≤4.3–7.2 µm broad hyphae; stipe trama made up of rosettes of sphaerocysts intermingled with ≤ 5.7 µm broad hyphae. Laticifers present throughout the context of carpophores. Clamp connection absent.



Figs 1–5. *Lactarius annulocystidiata*: microscopic structures.
1. Carpophore; 2. basidiospores; 3. basidia; 4. pleurocystidia; 5. cheilocystidia

Remarks— *Lactarius annulocystidiatus* is characterized by its viscid, light yellow pileus surface with pinkish to reddish brown tinge, unbearded margins, grayish milky mild unchanging latex in young fruit body and all parts of the

Fig. 6. *Lactarius annulocystidiata* in situ.

fungus becoming brownish on bruising. These features are typical of subgenus *Tristes,* section *Pseudomyxacium*, stirps *Argillaceifolius* (sensu Hesler & Smith, 1979). It seems to be a close relative of *L. argillaceifolius* Hesler & A.H. Sm. var. *argillaceifolius,* which can be separated in the field by its pubescent margin and decurrent closely placed lamellae. Microscopically, the basidiospores of *L. argillaceifolius* var. *argillaceifolius* are larger [(7–)8–10(–11) × 7–8 µm], the pleurocystidia and cheilocystidia, which are larger and clavate, lack granulations around the tips, and the pileus surface lacks ampulliform, H-shaped branched hyphae.

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A new species of *Lentinus* from India

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Abstract—*Lentinus alpacus* sp. nov. is described, illustrated, and discussed based on collections made in Maharashtra State, India. *Lentinus alpacus* is tentatively placed in subg. *Panus* sect. *Panus,* where it is distinguished by its small, reddish brown, squarrose basidiomata.

Key words—*Basidiomycota, Polyporaceae, Polyporales,* taxonomy

Introduction

The genus *Lentinus* sensu Pegler (1983b; *Polyporaceae*) is widespread in the tropics. A review of literature (Manjula 1983; Natarajan et al. 2005; Kumaresan & Senthilarasu unpubl. data) revealed that the genus is well represented in India. Several species have been described and reported from Kerala State alone (Manimohan & Leelavathy 1995; Joseph et al. 1995; Manimohan et al. 2004; Kumar & Manimohan 2005), but only one species, *L. cochleatus*, has been reported from Maharashtra State (Trivedi 1972). In this paper, a new species of *Lentinus* collected from Pune, Maharashtra State, is described, illustrated, and discussed.

Materials & methods

Thin, handmade sections were made from dried specimens, revived in 10% KOH, and stained in 3% Phloxine. Fifty basidiospores were measured for evaluation of the range of spore-size and extreme values are given in parentheses followed by mean spore measurements in parentheses. Camera lucida diagrams were made using a Nikon Y-IDT prism attached to a Nikon E200 microscope. Microphotographs were made using Zeiss Axio Imager A2 microscope. The colour names and notations used are from Kornerup & Wanscher (1978). The examined collections cited are deposited at Ajrekar Mycological Herbarium (AMH), MACS' Agharkar Research Institute, Pune, India.

Taxonomy

Lentinus alpacus Senthil. & S.K. Singh, **sp. nov.** PLATES 1, 2

MYCOBANK MB563805

Differs from *L. courtetianus* in a squarrose red pileus and thin, hispid stipe.

TYPE: India, Maharashtra State, Pune, Pune University Campus (18°31′18.4″N 73°49′53.6″E), on decaying twigs, solitary, 21.07.2011, G. Senthilarasu (**holotype**, AMH 9442).

ETYMOLOGY: *alpacus* (Sanskrit), small.

PILEUS 6–25 mm diam., orbicular, plano-concave or infundibuliform; surface Venetian red (8D7) to Persian red (8E8), squarrose: scales reddish brown (9F8), more towards the disc, at first often with purplish tints; margin incurved, thin, entire, ciliate, not striate. LAMELLAE subdecurrent, white to orange white (5A2) to pale orange (5A3) to grayish orange (6B3), becoming dark brown (8D4-8D5) on drying, crowded, with numerous lamellulae, thin, less than 1 mm broad; edge entire, concolorous with the sides. STIPE central to excentric, rarely lateral, 14–25 × 1–1.5 mm, equal, cylindric; surface reddish brown (8E8-9F8), hispid, solid, arising from concolorous basal tomentum. PILEUS CONTEXT ≤1 mm thick, orange white (5A2) to pale orange (5A3).

BASIDIOSPORES (5–)5.5–6.5(–7) × (2–)2.5–3(–3.5), (6.1±0.31 × 2.9±0.14) µm, Q = 2.1, oblong-ellipsoid to subcylindric, hyaline, smooth, with a few guttules. BASIDIA 18–25 × 5–6.5 µm, cylindrico-clavate to clavate, tetrasporic; sterigmata up to 5 µm long. LAMELLA EDGE sterile, with scattered cheilocystidia together with metuloids. CHEILOCYSTIDIA 20–30 × 8–12 µm, clavate to subclavate with broadly rounded apex, hyaline, thin-walled. PLEUROCYSTIDIA abundant, gloeocystidioid, 18–45 × 5–11 µm, cylindrico-clavate with obtusely rounded apex, often constricted, initially embedded within the hymenium and projecting 20 µm beyond the basidia. METULOIDS scattered, on sides and edge of lamellae, 19–25 × 7–11.5 µm, thick-walled, 1–3.5 µm thick, subventricose with an obtusely rounded apex, projecting 15 µm beyond the basidia. LAMELLA TRAMA irregular, consisting of thick walled, hyaline, skeletal hyphae 2–2.5 µm diam. SUBHYMENIUM indistinct. PILEAL SURFACE a regular cutis consisting of radially repent hyphae, often disrupting to form pileal squamules at the margin, distinctly trichoderm at the disc due to more squamules; squamules up to 840 × 80 µm, composed of fascicles of monomitic hyphae, up to 5 µm diam., often containing brown vacuolar sap, thick-walled, septate with clamp connections. PILEAL CONTEXT consisting of dimitic hyphal system; generative hyphae up to 3 µm diam., not inflated, hyaline, thin-walled, with clamp connections, often collapsing and difficult to observe; skeletal hyphae up to 2.5 µm, hyaline, unbranched, thick-walled, with a narrow lumen. HYPHAL PEGS absent.

ADDITIONAL SPECIMENS EXAMINED: **INDIA, MAHARASHTRA STATE**, Pune, Pune University Campus (18°31′18.4″N 73°49′53.6″E), 03.08.2009, (AMH 9457), 26.07.2012, (AMH 9526), 01.08.2012 (9527) G. Senthilarasu.

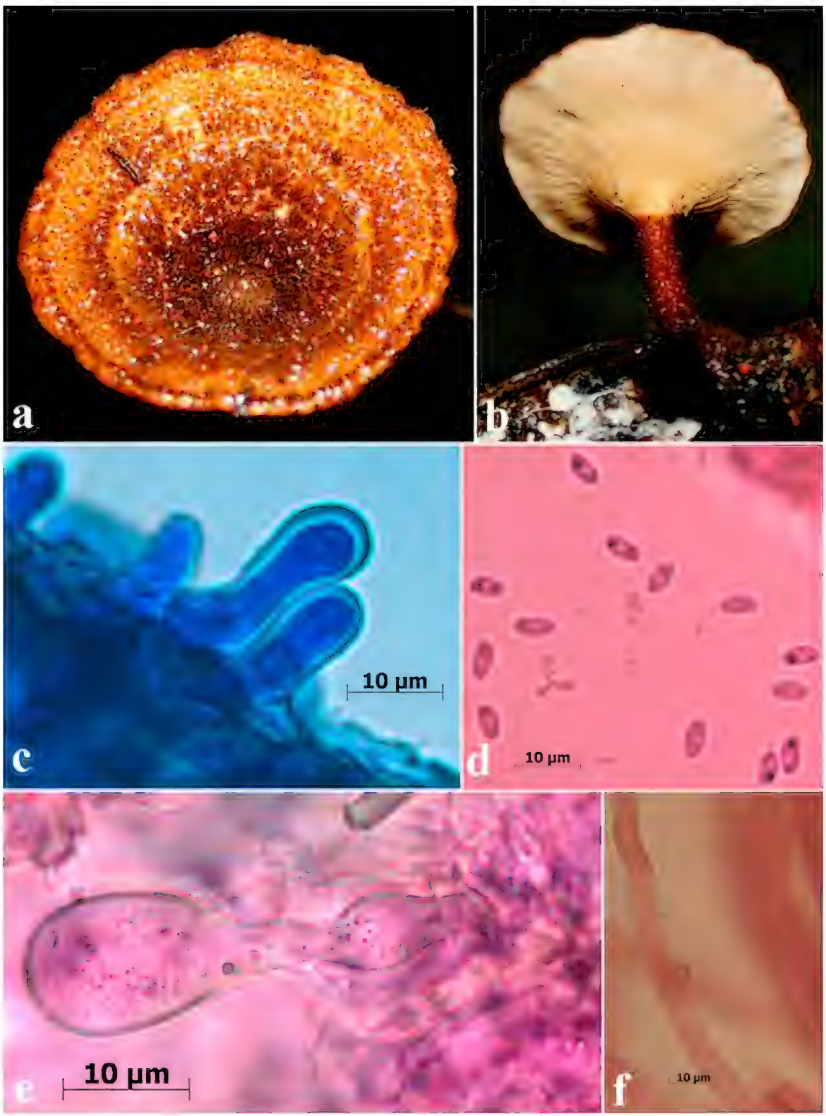

Plate 1. *Lentinus alpacus*: Under natural conditions on Pune University Campus. A. Surface view. B. Gill view. C. Metuloids. D. Basidiospores. E. Gloeocystidia. F. Pileipellis generative hypha with clamp connection. Photo: Senthilarasu G.

Lentinus alpacus is a fairly common and widespread species in the Pune University Campus but usually found solitary on decaying twigs every year during monsoon. The habit is also (rarely) connate, with a single basidiome arising from the stipe apex of partly decayed basidiome.

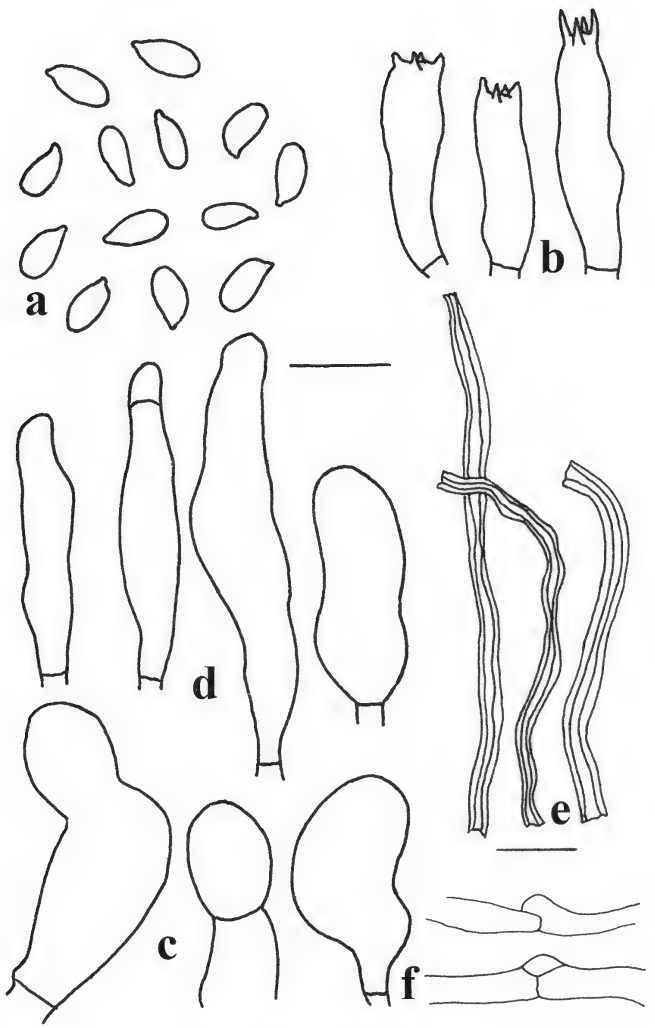

Plate 2. *Lentinus alpacus*:
A. Basidiospores. B. Basidia. C. Cheilocystidia. D. Pleurocystidia. E. Skeletal hyphae.
F. Generative hyphae with clamp connections. Scale bar = 10 µm.

The generic demarcation and phylogenetic relationships of *Panus* Fr. and *Lentinus* Fr. are controversial (Corner 1981; Pegler 1983b; Singer 1986; Hibbett & Vilgalys 1991, 1993, Grand et al. 2011). These have been accepted as separate genera by many modern authors (Corner 1981; Moser 1978; Singer 1975, 1986), but were reduced by Pegler (1983b) to subgenera within a broader

concept of *Lentinus*. Redhead & Ginns (1985) created the genus *Neolentinus*, characterised by bipolar mating systems and the ability to cause brown rot, to accommodate species from *Lentinus* sections *Pulverulenti*, *Cirrhosi*, and *Squamosi* sensu Pegler (1983b). *Lentinus* sensu stricto is characterized by species having radiate, descending, or intermediate tramas with ligative hyphae and hyphal pegs in the hymenium, whereas *Panus* sensu stricto is distinguished by strongly radiate hymenophoral trama with dimitic hyphae and lacking hyphal pegs. Additionally, in *Panus* young basidiomata are brightly pigmented in purple and fade with age (Hibbett et al 1993). At present it is not clear to which segregate genus *L. alpacus* belongs. However, it could be accommodated in subgenus *Panus* sensu Pegler (1983b) as it lacks both skeleto-ligative hyphae in the context and hyphal pegs in the hymenium, and in section *Panus* based on its hymenial cystidia, hymenophoral trama of radiate construction and entire lamella edge. Therefore, we have followed the broad *Lentinus* concept of Pegler (1983b).

In sect. *Panus,* one African species, *L. courtetianus* Har. & Pat. (Pegler 1983b), resembles *L. alpacus* in having more or less similar sized basidiomata and cheilo- and pleurocystidia. However, *L. courtetianus* has a smooth, pure white or lemon yellow tinted pileus and thicker (3–10 mm diam.), smooth, glabrous, subbulbous stipe.

Lentinus alpacus closely resembles the neotropical species *L. tephroleucus* Mont. (Pegler 1983b) in having small, infundibuliform pileus with short erect fasciculate hairs that become squamulose towards margin and similar sized basidiospores and basidia. However, *L. tephroleucus* has a pale yellowish to grayish brown or cinnamon brown pileus with glabrescent disc and cream coloured lamellae. Microscopically, *L. tephroleucus* is clearly unrelated from *L. alpacus* because of its sclerocystidia.

The southeastern Asian species *Lentinus ciliatus* Lév. (Pegler 1983b) also shares a squamulose pileus and similar-sized spores and basidia but differs in its larger basidiomata, cinnamon to fuscous brown pileus with densely ciliate margin, and thick-walled sclerocystidia.

Lentinus leprieurii Mont. (Pegler 1983a), which resembles *L. alpacus* in its brown pileus with fasciculate hairs, short stipe, and similar-sized basidiospores and basidia, differs in its larger pileus, brown lamellae, thicker stipe (≤ 6 mm), cylindric cheilocystidia, and absence of pleurocystidia. Moreover, *L. leprieurii* grows in tufts, not solitary.

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Two new species in the *Graphidaceae* (*Ostropales, Ascomycota*) from China

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Abstract— During an examination of subtropical and tropical lichen collections from China, two species, *Fissurina isidiata* collected from Hainan Island and *Graphis wangii* collected from Yunnan province, were discovered and are reported as new to science.

Key words— lichenized fungi, taxonomy

Introduction

During the study of the lichen family *Graphidaceae* from China, two interesting corticolous species of *Fissurina* and *Graphis* were found that are reported here as new to science following the new generic concept of the *Graphidaceae* proposed by Staiger (Staiger 2002). The types of the new species are deposited in HMAS-L, LHS and KUN-L in China.

Material & methods

The examined material was collected by the author from Hainan Island and preserved in HMAS-L LHS and KUN-L. Morphological characters were studied on dry specimens using dissecting microscope (Tech XTS-20) and anatomical characters were examined in hand-cut sections of lirellae mounted in water using a research microscope (Olympus CHB-213). The lichen compound was detected by thin-layer chromatography (TLC) (Culberson & Kristensson 1970; Culberson 1972).

Taxonomy

Fissurina isidiata Z.F. Jia, **sp. nov.** Pl. 1

Fungal Name FN570009

Sicut Fissurina astroisidiata, *sed sporis longioribus et acido stictico continente differt.*

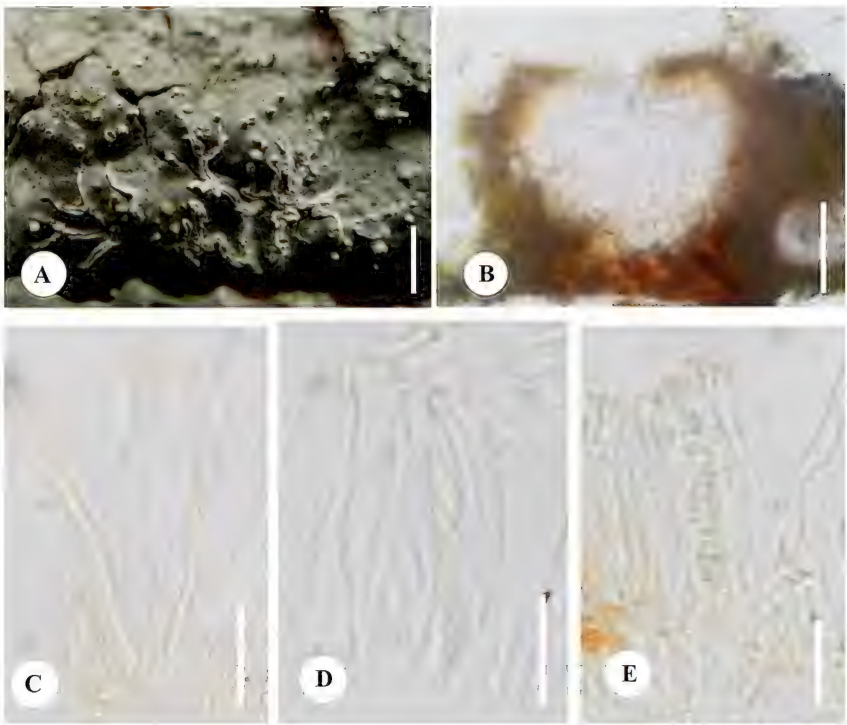

Plate 1 *Fissurina isidiata*. A. Thallus with isidia (bar = 10 mm); B. Cross section of an apothecium (bar = 50 mm); C–E. Ascospores in asci (bar = 50 μm).

Type: China. Hainan Island, Mountain Wuzhi, 18°46′N 109°31′E, alt. 950 m, 30.XI.2010, Ze-Feng Jia 10-612 (**Holotype**, HMAS-L 117919; **isotype**, LHS).

Etymology: from the Latin *isidium*, referring to the isidiate thallus.

Thallus corticolous, crustose, pale green to olive-green, uneven, isidiate, isidia simple, concolorous with the thallus, 0.2–0.3 mm in diameter and 0.3–1.2 mm high, distributed over the thallus.

Ascomata lirelline, lirellae greyish white, 1–10 mm long, usually simple, sometimes branched, more branched at the end of lirellae, fissured, immersed to slightly raised. Disc slit-like, narrow to moderately broad, epruinose, sometimes open when aged. Exciple complete, present below, non-striate, non-carbonized, yellow to dark orange-brown, sometimes becoming darkened laterally or apically, convergent, covered by a thalline margin. Hymenium hyaline, not inspersed, 60–80 μm high, I–, KI–. Hypothecium distinct, thin, pale, 6–8 μm high. Paraphyses simple, 1.5–2.0 μm thick. Periphysoids short to moderately elongate, 3–6 μm long, with warty tips. Asci 8-spored, 50–75 × 5–12.5 μm. Ascospores hyaline, oval or broadly ellipsoidal, transversely

septate when younger, submuriform to muriform, becoming 2–6 × 1–2-locular with age, mature spores 15–20 × 5.5–7.5 µm, sometimes with a halo, I+ reddish violet.

Chemistry: stictic acid present (TLC).

Substrate & distribution: The type specimen was collected in the central region of the Nature Reserve of Mountain Wuzhi with a tropical forest located in the central part of Hainan Province, Southern China. *Fissurina isidiata* is so far known only from the type material. Associated species are *Graphis japonica* (Müll. Arg.) A.W. Archer & Lücking and other graphidean lichens.

Notes: *Fissurina isidiata* is characterised by the presence of an isidiate thallus, fissurine apothecia, a non-carbonized exciple, a clear hymenium, small submuriform ascospores, and the presence of stictic acid. It is the second isidiate species found in the genus *Fissurina*, the first being *F. astroisidiata* Herrera-Camp. & Lücking described from Mexico (Lumbsch & al. 2011). The Mexican species is readily distinguished by shorter, stellately branched lirellae, smaller ascospores (12–15 µm long), and the absence of lichen compounds. *Fissurina abdita* (A.W. Archer) A.W. Archer also possesses small ascospores and stictic acid but is differentiated by a non-isidiate thallus and larger ascospores (18–35 × 8–10 µm and 8–10/2–3 locular as reported by Archer; 2006).

Graphis wangii Z.F. Jia, **sp. nov.** Pl. 2

Fungal Name FN570011

Species nova Graphis biferae *similis sed ascosporis submuriformibus differt.*

Type: China, Yunnan province, Xinping county, Mont. Mopanshan, 23°55′N 101°58′E, alt. 2350 m, on bark of *Quercus* sp.. 3.I.2009. coll. Li-Song Wang 09-30091 (**Holotype**, KUN-L).

Etymology: The new species is named in honour of the esteemed Prof. Li S. Wang, a famous collector and conservator of lichens and mosses from China.

Thallus corticolous, crustose, pale white to whitish grey, surface dull, unevenly thickened, tightly attached to the substratum, without isidia and soralia.

Apothecia lirelliform, elongate to sinuous, simple or rarely branched, 0.5–5 mm long, 0.4–0.5 mm wide, sessile, lacking a thalline margin, black, curved and straight, often rounded at the ends, not striate, scattered over the thallus, disc concealed. Proper exciple conspicuous, completely carbonised. Epithecium 3–5 µm thick, brownish. Hymenium colorless, not inspersed, 180–230 µm high, I–. Hypothecium colourless to brownish, 30–40 µm high. Paraphyses simple, up to 1–1.5 µm wide, apices unbranched. Asci cylindrical to clavate, 110–160 × 15–25 µm, 2–8-spored. Ascospores hyaline, oblong to ellipsoid, transversely septate or with a few central longitudinal septa, 14–20/1–2-locular, 70–103 × 13–20.5 µm, I+ blue-violet.

Chemistry: C–, K–, P–; no lichen compounds detected by TLC.

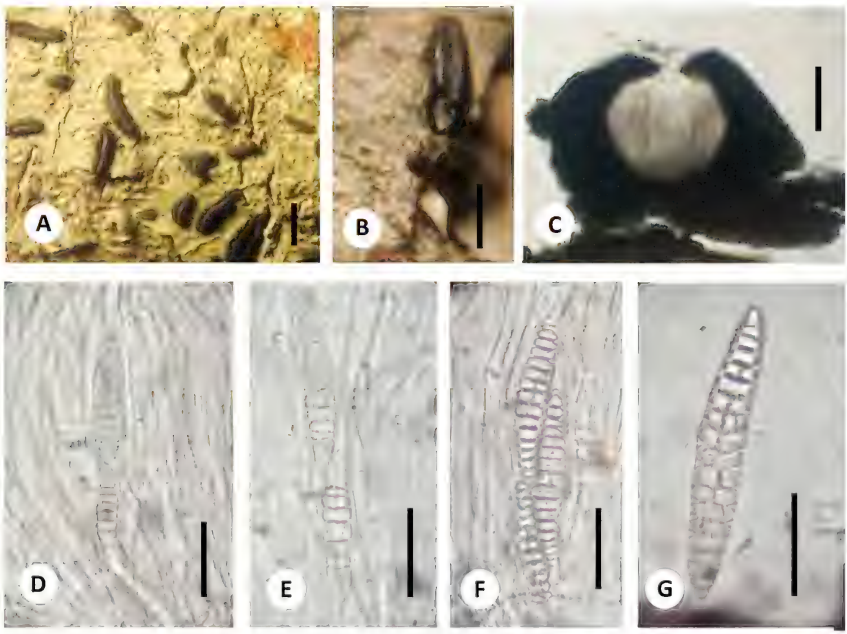

Plate 2 *Graphis wangii*. A. Habit (bar = 2 mm); B. Lirellae showing completely carbonized exciple (bar = 2 mm); C. Cross section of an apothecium (bar = 100 μm); D–F. Asci with ascospores (bars = 50 μm); G. Ascospore (bar = 50 μm).

Notes: *Graphis wangii* is characterized by simple or seldom branched, sessile, lirellae, lacking a thalline margin, *nuda* morph ascomata, a completely carbonized exciple, and a clear hymenium, with submuriform ascospores and lacking lichen compounds.

The new species has similar thallus and lirella morphology and similar chemistry to *G. bifera* Zahlbr., which differs in having ascospores with 15–21 transverse septa (Lücking et al. 2009).

Graphis wangii also resembles *G. lourdesina* Aptroot, described from Brazil (Lücking et al. 2009). Both species have short, simple sessile lirellae, muriform ascospores, and lack thalline margins and lichen compounds, but *G. lourdesina* differs in larger ascospores, 100–120 × 30–35 μm.

At present, the new species is known only from the Mopanshan National Forest Park. It grows on the trunks of *Quercus* sp.

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Tricholomopsis in Europe — phylogeny, key, and notes on variability

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Abstract— *Tricholomopsis* (*Basidiomycota*, *Agaricales*) species in Europe were studied by classical and molecular methods (morphology, anatomy; sequences of nuclear rDNA containing ITS1, ITS2, 5.8S and part of 28S regions). The identity of four species was confirmed: *T. rutilans*, *T. flammula*, *T. decora*, *T. osiliensis*. Within *T. flammula*, two well-supported groups were recovered. An identification key based on a better understanding of the species limits was prepared. All species are briefly characterized and their variability is discussed. *Tricholomopsis ornata* should be rejected; it is considered a doubtful, poorly documented taxon, and the name has been variously interpreted.

Key words— *Fungi*, macromycetes, taxonomy, nomenclature

Introduction

The genus *Tricholomopsis* Singer is represented in Europe by a rather small number of species. Most authors recognise only the well-known species *T. rutilans* and *T. decora* (e.g., Boekhout & Noordeloos 1999, Gröger 2006, Vesterholt 2008). Some identification keys give two more species, namely *T. flammula* and *T. ornata* (Moser 1983, Bon 1995, Horak 2005). The identity of *T. flammula* was documented recently using both classical and molecular methods (Holec 2009, Holec & Kolařík 2011). In 2009, the new species *T. osiliensis* was described by Vauras (2009) from the Estonian island Saaremaa (Osilia in Latin). Four species (*T. rutilans*, *T. ornata*, *T. flammula*, *T. osiliensis*) are reported from Estonia (Kalamees 2011). Altogether, five species have been reported from Europe. However, *T. ornata* is poorly documented as there are no well-described records agreeing with the original description by Fries (1838) and a detailed DNA study comparing the species is absent.

In the molecular phylogenetical study by Moncalvo & al. (2002) *Tricholomopsis,* represented by the nuclear LSU rDNA sequence of *T. rutilans,*

was placed in one phylogenetic clade together with *Clavaria fusiformis* and *Marasmius rhyssophyllus*. In a multigene dataset (RPB1, RPB2, ncRNA) another representative species, *T. decora*, fell into a pluteoid clade, outside of any conventional families, close to *Amanitaceae* (Matheny & al. 2006). To date, a detailed DNA study has been published only on *T. flammula* (Holec & Kolařík 2011).

The aim of this study is to verify the identity of *Tricholomopsis* species in Europe by classical and molecular methods and to prepare an identification key based on a better understanding of species limits.

Material & methods

Morphological study

Fresh and dried collections of *Tricholomopsis* species from Europe were studied. Voucher specimens are kept in herbaria PRM, WU, TU, and TUR-A (formerly TURA). For herbarium acronyms see Thiers (2012). All collections were studied by traditional taxonomic methods (generally: Singer 1986, Bas & al. 1988; specifications: Holec 2009). Spore sizes are presented as the main data range (c. 10–90 percentile values), flanked by extreme values in parentheses, of all spores measured (20 measurements per collection). The spores were measured directly in the microscope using the eyepiece micrometer with the basic scale division of 0.8 µm and distinguishable difference of 0.4 µm. Thus, the scale reading was made in the following steps (in µm): 1.6, 2.0, 2.4, etc.

DNA study

Genomic DNA from nine herbarium specimens (Tab. 1) was isolated using ArchivePure DNA Yeast and Gram-+ Kit (5 PRIME, Inc. Gaithersburg, MD) with modified time of the incubation with Lytic Enzyme Solution (2h, 37 °C) and Cell Lysis Solution (4h, 64 °C). Nuclear rDNA containing internal transcribed spacers (ITS1 and ITS2), 5.8S and part of 28S regions was amplified with primer set ITS1/LR6 (Gardes & Bruns 1993; Vilgalys & Hester 1990). The reaction mixtures and amplification protocols for rDNA regions were made according to Hulcr & al. (2007) except of polymerase, PerfectTaq Plus DNA Polymerase (5 PRIME, Inc. Gaithersburg, MD) which was used here to overcome amplifications problems. Custom purification of PCR products and sequencing was done at Macrogen Inc. (Seoul, South Korea) using the primers ITS1, ITS4S, LR6, NL1 and NL4 (Gardes & Bruns 1993; O'Donnell 1993). Sequences were combined with the most related published *Tricholomopsis* rDNA (Tab. 1) sequences from well documented specimens and aligned in MAFFT v6.861b using Q-INS-i strategy considering secondary structure of rRNA (Katoh & Toh 2008). To filter both gaps and hyper variable regions, we used Gblocks version 0.91b (Talavera & Castresana 2007) with less stringent selection allowing smaller final blocks and gap positions within the final blocks. There were a total of 19 sequences and 1119 positions in the final dataset (unpruned dataset contained 1786 positions) from which 843 were conservative and 274 variable. Maximum likelihood (ML) and Minimum Evolution (ME) analyses were conducted with 1000 bootstrap replicates and default parameters in MEGA 5.0 (Tamura & al. 2011). In both analyses, all positions with less than 5% site coverage were eliminated.

Table 1. *Tricholomopsis* collections used for DNA analysis.

Species	Country	Locality	Reference	GenBank	Voucher
T. flammula	Czech Rep.	Boubínský prales	Holec (2009), Holec & Kolařík (2011)	FN554893	PRM 899108 (JH 149/2008)
	Czech Rep.	Čerňava	Holec & Kolařík (2011)	FN554894	PRM 899459 (JH 227/2008)
	Czech Rep.	Na Stříbrné	Holec & Kolařík (2011)	FN554896	PRM 909608
	Slovakia	Badínsky prales	This study	HE649939	PRM 899162 (JH 140/2009)
	Slovakia	Dobročský prales	This study	HE649940	PRM 899180 (JH 162/2009)
	Slovakia	Dobročský prales	This study	HE649941	PRM 899190 (JH 172/2009)
	Austria	Eichberg	Holec & Kolařík (2011)	FN554897	WU 12087
	Austria	Rote Au	Holec (2009)	FN554892	WU 25091
	Austria	Dürradmer	This study	HE652866	WU 13075
	Pakistan	Diamir, Fairy Meadows	Razaq & Khalid (unpublished)	FR822742	SR 161
T. decora	Czech Rep.	Olšinka	Holec & Kolařík (2011)	FN554890	PRM 882317
	Czech Rep.	Malá Niva	Holec & Kolařík (2011)	FN554891	PRM 898238 (JH 218/1997)
	Slovakia	Badínsky prales	This study	HE649942	PRM 899160 (JH 145/2009)
	USA	Massachusetts, Harvard Forest	Petersen & Hughes (2012)	DQ404384	TENN 62342 (PBM 2482)
T. osiliensis	Estonia	Saaremaa	Vauras (2009), this study	HE649943	PRM 899461 (isotype)
	Estonia	Vormsi	This study	HE649944	TU 101571
	Slovakia	Dobročský prales	This study	HE649945	PRM 899184 (JH 166/2009)
T. rutilans	Czech Rep.	Mt. Kamenná	Holec (2009)	FN554895	PRM 889120 (JH 362/1996)
	Czech Rep.	Kamenný vrch hill	This study	HE649946	PRM 899460 (JH 91/2009)
	Canada	BC, Capilano River	Johnston (2006)	EF530929	UBC F16251

Bayesian searches (MB) were conducted with MrBayes 3.0 (Ronquist & Huelsenbeck 2003) and 1.5 million replicates estimated together with burn-in value in Tracer v1.5 (Rambaut & Drummond 2007). *Pluteus romellii,* known as related to the *Tricholomopsis* group (Matheny & al. 2006), was chosen as outgroup. Sequences obtained in this study were submitted to GenBank (Tab. 1).

Abbreviations

bp: base pairs, JH: Jan Holec, Q: quotient of length/width of the spores, MB: Bayesian analyses using MrBayes, ME: Minimum Evolution analysis, ML: Maximum Likelihood analysis, Qav: mean value of Q in each of the collections studied.

Results and discussion

DNA study

The phylogenetic analysis computed by all three methods consistently recovered five major supported clades (Fig. 1). ME showed the highest statistical supports from all methods. The first clade consists of *T. decora* sequences, where specimen PRM 899160 (1521 bp) showed one base pair difference from two other European specimens and nine base pairs difference from the USA specimen. The next two clades consist of *T. flammula* specimens. The major clade is divided further into two moderately supported subgroups differing in four positions from 1521 bp. Specimen PRM 899190 differs in seven positions in the ITS regions and eleven in the LSU region from the specimen PRM 899108, which represents the second clade. Sequences from *T. rutilans* specimens formed a clade with material from Canada exhibiting ten different positions in the ITS region and six positions in the LSU region. The last clade consists of the little variable group of *T. osiliensis* specimens.

Phylogenetic analysis recovered lineages corresponding with our morphological observations and showing *T. decora*, *T. flammula*, *T. osiliensis* and *T. rutilans* as well defined taxa. Two of the studied species (*T. decora* and *T. rutilans*), known also in North America, showed the presence of vicariant populations resulting evidently from the running allopatric speciation. Our DNA analysis also revealed two well-supported groups ("species") within *T. flammula*. Delimitation of species based solely on molecular data of a single locus, especially in closely related taxa, is tricky. Additional distinguishing characters obtained from more collections could elucidate whether the specimen PRM 899108, previously shown as morphologically different from other *T. flammula* collections (Holec & Kolařík 2011), really represents a separate species.

Key to critically revised *Tricholomopsis* species in Europe

1a. Fibrils or scales on pileus surface red to violet 2

1b. Fibrils or scales on pileus surface without red to violet colour 3

2a. Spores broadly ellipsoid to subglobose, Q = 1.14–1.55, Qav = 1.30–1.35, width 4.0–6.5 µm; mature basidiocarps large and fleshy, stipe always covered with red-violet fibrils to scales ..... ***T. rutilans***

2b. Spores ellipsoid, Q = 1.33–2.11(–2.44), Qav = 1.50–1.90, width 3.2–4.8 µm; mature basidiocarps slender, mostly (not usually) small to medium-sized, stipe mostly yellow, rarely covered with red-violet fibrils ..... ***T. flammula***

3a. Pileus covered with yellow-green, bronze, olive-brown to olive-black, distinctly upraised scales on brightly yellow to orange ground ..... ***T. decora***

3b. Pileus covered with yellow-ochre to orange-brown, fine to coarse, adpressed fibrils or fine scales on less bright, yellow to ochre ground ..... ***T. osiliensis***

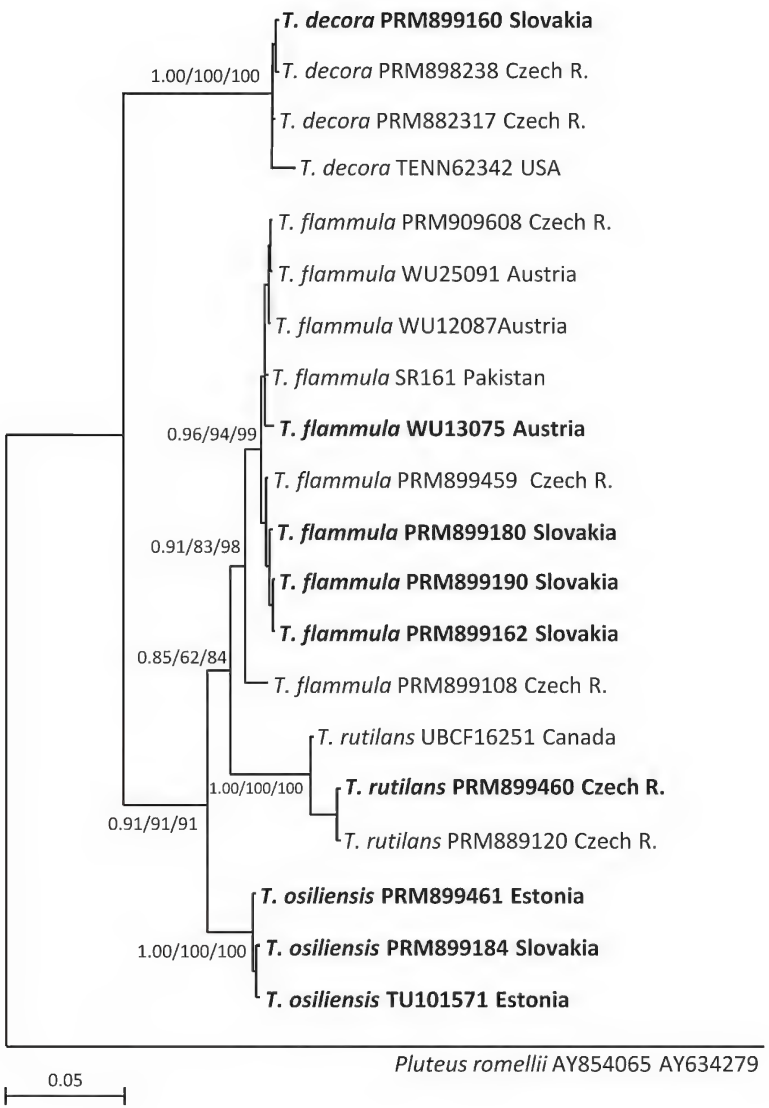

FIGURE 1. ITS-LSU rDNA based phylogram obtained from Bayesian inference depicting relationships among European *Tricholomopsis* species. The numbers from left to right refer to posterior probabilities of the Bayesian Markov chain Monte Carlo analysis, percentage bootstrap values of Maximum Likelihood and Minimum Evolution analysis. Values smaller than 50% are not shown. Branch lengths are scaled in terms of expected numbers of nucleotide substitutions per site. Sequences printed in bold were obtained during this study.

Tricholomopsis rutilans (Schaeff. : Fr.) Singer 1939

Selected descriptions and icones. Breitenbach & Kränzlin (1991: no. 445), Ryman & Holmåsen (1992: 281), Boekhout & Noordeloos (1999: 151–152), Ludwig (2000: no. 85.3.B, C; 2001: 680), Roux (2006: 380), Vesterholt (2008: 334–335).

Diagnostic characters — Basidiocarps large and fleshy when mature, pileus and stipe densely covered with red-violet fibrils to scales. Spores broadly ellipsoid to subglobose, rarely broadly obovoid or ellipsoid, 5.0–8.5 × 4.0–6.5 μm, Q = 1.14–1.55, Qav = 1.30–1.35; pleurocystidia absent or rare.

Distribution and ecology — Common throughout Europe; living on dead wood of conifers, often buried in soil; in all forest types, in clearings, along forest roads, in parks and gardens.

Comments — *Tricholomopsis rutilans* is easily recognizable by the large and fleshy basidiocarps (when mature), red-violet fibrils or scales on pileus and stipe surface, and above all by the broadly ellipsoid to subglobose spores. A typical *T. flammula* mostly differs by slender basidiocarps with yellow stipes and more elongated (ellipsoid), more slender spores. However, in some cases its basidiocarps reach almost the same size as those of *T. rutilans* and the stipe is covered by violet fibrils, especially when young. In such cases, the spore shape and size (see the key above) and abundance of pleurocystidia are decisive for correct identification of *T. flammula*.

Collections studied — **CZECH REPUBLIC**. Krkonoše Mts., Rokytnice n. Jizerou: Dvoračky, decayed trunk of *Picea abies*, 13.X.1946 leg. J. Kubička (PRM 520341). Central Bohemia, Dobřichovice, on bark of *Picea abies*, 15.X.1996 leg. M. Svrček (PRM 889808). Šumava Mts., Mt. Kamenná, on soil under *Picea*, 28.VIII.1996 leg. J. Holec (PRM 889120). Nová Bystřice, stream valley S of Kamenný vrch hill, on stump of *Picea abies*, 17.IX.2009 leg. J. Holec (PRM 899460). **SLOVAKIA**. Západné Tatry Mts., Mt. Osobitá, on decayed trunk of *Picea abies*, 7.IX.1979 leg. R. Leontovyč (PRM 821774). **UKRAINE**. Eastern Carpathians, Dilove ("Trebušany"), Mt. Menchul ("Menčul"), *Abies alba*, VIII.1934 leg. A. Pilát (PRM 497334).

Tricholomopsis flammula Métrod ex Holec 2009

Selected descriptions and icones. Métrod (1946: p. 77, pl. 1: fig. 5), Cetto (1995: fig. 1010), Krisai-Greilhuber & Voglmayr (2000), Holec (2009), Holec & Kolařík (2011).

Diagnostic characters — Basidiocarps slender, not fleshy, small to medium-sized, rarely large (pileus ≤ 11 cm), young pileus densely covered with fine red-violet to purplish brown fibrillose scales which become scarce on mature pileus, stipe mostly pale yellow, lemon-yellow to bright yellow, rarely (especially when young) covered with fine, red-violet to violet-brown fibrils. Spores variable in length, rather elongated, ellipsoid, (5.2–)5.6–8.0(–8.8) × 3.2–4.8 μm, Q = 1.33–2.11(–2.44), Qav = 1.50–1.90, pleurocystidia abundant, with pale yellow refractive content.

Distribution and ecology — Widespread but rare throughout Europe; on dead conifer wood, mostly fallen decaying trunks of *Abies* and *Picea*, rarely on wood of deciduous trees (*Fagus*), in forests, shrubs and abandoned orchards; from the hilly country to the mountains. In the Czech Republic and Slovakia, the species clearly prefers natural to virgin forests; however, records from habitats strongly influenced by man are known, too.

Comments — In most cases, *T. flammula* is a small to medium-sized fungus with a pileus ≤ 5(–8) cm broad. Rarely the pileus can reach a diameter of 11 cm (PRM 899191) but even then the basidiocarp remains slender (less fleshy) than similarly sized *T. rutilans* basidiocarps. In previous publications (Krisai-Greilhuber & Voglmayr 2000, Holec 2009, Holec & Kolařík 2011) a yellow stipe lacking red-violet fibrils or scales is emphasized as one diagnostic character of *T. flammula*. Ample material collected in Slovakia in 2009 (see below) showed that in some collections the young stipe is almost completely covered with a fine violet felt which is present even in older basidiocarps as sparse violet-brown fibrils. Simultaneously, spores were unusually elongated in the Slovak collections, reaching a Qav of 1.72–1.90 in comparison with Qav of 1.51–1.63 in the previously studied collections (Holec & Kolařík 2011). These collections (including PRM 899459 from the Moravian Carpathians), grouped together also in our phylogram (Fig. 1), differ from sister "western and central European clade" in four positions in the entire ITS-LSU region. This group seems to represent a slightly deviating "Carpathian" *T. flammula* subpopulation characterized by larger basidiocarps and more elongated spores (with Q often reaching 2.00–2.44 and Qav = 1.72–1.90). The "western and central European" subpopulation has smaller basidiocarps and less elongated spores (with Q = 1.33–2.00; Qav = 1.51–1.63). In any case, the differences in DNA sequences are negligible and show at most the beginnings of a vicariance.

Consequently, basidiocarp size and stipe surface color are not stable characters and have a limited value for distinguishing *T. flammula* and *T. rutilans*. The reliable distinguishing characters of *T. flammula* are the spore shape and width and the abundance of pleurocystidia (see the key above for details).

Tricholomopsis flammula is a variable species where three infraspecific subdivisions were revealed by molecular methods (i.e. two well-supported groups, one with two moderately supported subgroups, representing the subpopulations discussed above). This fact is phenotypically expressed by variable macrocharacters (see above), a variability previously discussed in Holec & Kolařík (2011) based on a smaller number (5) of molecularly studied collections than here (10). However, the problem remains unresolved. The first clade revealed here is represented by a morphologically variable group of specimens comprising the two subpopulations discussed above and having

both small and medium to large basidiocarps and larger (especially longer) spores [5.6–8.0(–8.8) × 3.2–4.8 µm]. The second clade is represented by only one collection (PRM 899108: Boubínský prales) with rather small, pale basidiocarps (Holec & Kolařík 2011: fig. 4) and small spores [(5.2–)5.5–6.4 × 3.2–4.0 µm]. More collections are needed to understand the limit between the two clades.

Collections studied — See Holec (2009) and Holec & Kolařík (2011) for collections from **CZECH REPUBLIC**, **AUSTRIA** and **FRANCE**.

Additional collections. **SLOVAKIA**. Kremnické vrchy Hills, virgin forest Badínsky prales, fallen decaying trunk of *Abies alba*, 28.IX.2009 leg. J. Lederer (PRM 899162, 899164). Veporské vrchy Mts., virgin forest Dobročský prales, fallen trunk (*Picea*? *Abies*?), 29.IX.2009 leg. S. Komínková (PRM 899180); fallen decaying trunk of *Abies alba*, 30.IX.2009 leg. J. Holec (PRM 899190, 899191).

Tricholomopsis decora (Fr. : Fr.) Singer 1939

Selected descriptions and icones. Breitenbach & Kränzlin (1991: no. 444), Ryman & Holmåsen (1992: 281), Boekhout & Noordeloos (1999: 151–152), Ludwig (2000: no. 85.1; 2001: 678), Roux (2006: 381), Vesterholt (2008: 335).

Diagnostic characters — Basidiocarps medium-sized, ground color yellow to orange, pileus covered with densely arranged, upraised, yellow-green, bronze, olive-brown to olive-black scales. Spores variable in size and shape, broadly ellipsoid to ellipsoid, rarely obovoid or slightly phaseoliform in side view, (6.0–)6.5–9.0(–10) × (4.0–)4.5–6.5(–7.0) µm, Q = 1.20–1.75, Qav = 1.40–1.54, pleurocystidia absent to rare.

Distribution and ecology — Scattered to common throughout Europe; living on dead conifer wood, especially on old stumps and decaying fallen trunks; in moist and shady mixed and coniferous forests, above all in the mountains.

Comments — *Tricholomopsis decora* is a species easily recognized especially from the bright colours and densely arranged upraised scales on pileus surface. For differences from *T. osiliensis* see below.

Collections studied. **CZECH REPUBLIC**. České Švýcarsko national park, site called Babylon, fallen decaying trunk of *Picea abies*, 16.VIII.2011, leg. J. Holec (PRM 899309). Šumava Mts., nature reserve Malá Niva, decaying trunk of *Picea abies*, 6.VIII.1997 leg. J. Holec (PRM 898238). Novohradské hory Mts., virgin forest Žofínský prales, decayed trunk of *Abies alba*, 30.IX.2008 leg. J. Borovička et J. Kubrová (PRM 915260). Hrubý Jeseník Mts., nature reserve Praděd, fallen decaying trunk of *Picea abies*, 25.VIII.2011 leg. J. Holec (PRM 899339). Nízký Jeseník Mts., nature monument Rešovské vodopády, fallen trunk of *Picea abies*, 23.VIII.2011 leg. J. Holec (PRM 899318). **SLOVAKIA**. Kremnické vrchy hills, virgin forest Badínsky prales, fallen decaying trunk of *Abies alba*, 28.IX.2009 leg. J. Holec (PRM 899160). Klenovec, Mt. Klenovský Vepor, decaying trunk of *Abies alba*, 31.VIII.1982 leg. F. Kotlaba (PRM 828487).

Tricholomopsis osiliensis Vauras 2009

Selected descriptions and icones. Vauras (2009).

Diagnostic characters — Basidiocarps medium-sized, yellow, yellow-ochre to brownish yellow, pileus 3.5-9 cm in diam., without distinct upraised scales but with concolorous minute squamules at margin (Vauras 2009) or with coarse, adpressed, ochre-brown fibrils or cords of fibrils (PRM 899184), becoming orange-brown when old. Spores variable in size and shape, broadly ellipsoid, ellipsoid, obovoid, rarely subglobose, 6.0–9.5 × 4.5–6.0 µm, Q = 1.14–1.85, Qav = 1.25–1.54; pleurocystidia present, scarce to frequent.

Distribution and ecology — Apparently a rare species, known from two Estonian islands in the Baltic Sea (Saaremaa: Vauras 2009, Vormsi: TU 101571) and Slovakia (virgin forest Dobročský prales, PRM 899184). The collections originate from fallen decaying trunks of *Picea abies* (Saaremaa, Vormsi) and *Abies alba* (Dobročský prales). It is possible that *T. osiliensis* also occurs in France, as a collection fitting its description was mentioned by Bon (1995) in his remark on *T. decora*.

Comments — The three *T. osiliensis* collections mentioned here form a well-supported clade with little molecular variability. Macro- and microscopically, the Slovak collection clearly differs from the Estonian ones in a pileus covered with coarse fibrils darker (orange-brown) than the ground; the Estonian basidiocarps exhibit almost smooth to finely fibrillose pilei with minute squamules that are present only at the margin. The striking nature of the Slovak fibrils was probably increased by their age and weather conditions (old and partly dried basidiocarps influenced by first autumn frosts). Additionally, spores in the Slovak basidiocarps were distinctly larger (8.0–9.5 × 5.2–6.0 µm) than in the Vormsi (6.0–7.2 × 4.8–5.6 µm) and Saaremaa (6.0–8.2 × 4.5–6.0 µm) collections (see Vauras 2009). However, a rather large spore size variability is typical for all European *Tricholomopsis* species (see above). The spores of *T. osiliensis* have a similarly broad range of spore length values.

Tricholomopsis osiliensis is a recently described, little known species. It is necessary to observe basidiocarp variability in future collections. Based on current data, *T. osiliensis* differs from *T. rutilans* and *T. flammula* by the absence of red-violet fibrils or scales and from *T. decora* by its almost smooth to fibrillose pileus without distinctly upraised scales and less bright pileus cuticle color. It is possible that some collections published as *T. ornata* represent in fact *T. osiliensis* (e.g. Courtecuisse & Duhem 2000: no. 419; see the discussion below).

Collections studied — **ESTONIA**. Island Saaremaa, Salme, Kaugatoma-Lõu, on fallen mossy stem of *Picea abies*, 18.IX.2008 leg. J. Vauras (isotype: PRM 899461). Lääne, island Vormsi, Saxby, rotten trunk of *Picea abies*, 19.IX.2010 leg. I. Saar (TU 101571).

SLOVAKIA. Veporské vrchy Mts., virgin forest Dobročský prales, fallen trunk of *Abies alba*, 29.IX.2009, leg. Š. Malec et P. Žitňan (PRM 899184).

Notes on *Tricholomopsis ornata*

Tricholomopsis ornata (Fr.) Singer is mentioned by some European authors (e.g. Moser 1983, Riva 1988, Bon 1995, Horak 2005). According to the original description by Fries (1838: 130), it is a medium-sized to large, fleshy fungus (pileus 5–12.5 cm broad, stipe about 1.2 cm thick) similar to *T. rutilans* but with a pileus covered with brown flocculose scales ("squamulis flocculosis fulvofuscescentibus"). No red-violet color is mentioned. We do not know any collection corresponding with this description. In the recent book on Scandinavian fungi (Vesterholt 2008), *T. ornata* is not mentioned, although it was originally described from the Uppsala vicinity growing on *Pinus* trunks. In our opinion, *T. ornata* is a doubtful, poorly documented taxon. It is possible that Fries (1838) described abnormal or old *T. rutilans* basidiocarps, which is supported by his note that *T. ornata* is similar to *T. rutilans*.

Bon (1995) is the only recent author describing *T. ornata* in detail and mentioning the material studied. However, his description differs from the original. Bon's fungus is smaller [pileus 3–6 cm, stipe 4–6(–8) × 0.3–0.5 cm] with adpressed, rusty brown to reddish scales on pileus surface and pale lemon-yellow stipe. These characters, including the rather large ellipsoid spores [(6–)7–9(–10) × 4.6–6.0 µm] and the presence of pleurocystidia, suggest that his *T. ornata* could represent *T. osiliensis*. A revision and molecular study of Bon's collections would be desirable to confirm this hypothesis.

Similarly, the illustrations of *T. ornata* by Courtecuisse & Duhem (2000: fig. 419, rather small yellow fungus with adpressed, fibrillose, vividly fulvous brown scales) do not correspond to the original *T. ornata* of Fries but do correspond well with our Slovakian collection of *T. osiliensis*.

Judging from our field experience with *Tricholomopsis* species, the Rebaudengo's illustration of *T. ornata* published in Riva (1988: 61) most probably represents aberrant *T. decora* basidiocarps. The scales agree with the Friesian description (small, floccose, fulvous brown), but the slender stature and bright yellow ground color are more typical of *T. decora*.

There are some recent photographs labeled as *T. ornata*. Those by Domínguez (2008) are closest to the original description by Fries; however, as they are not accompanied by an analysis of microcharacters, their identity remains unclear. On the other hand, the microcharacters presented by Musumeci (2004) clearly show that his *T. ornata* is in fact *T. flammula*.

The discussion shows that different interpretations of the name *T. ornata* exist. It seems that the original *T. ornata* represents aberrant basidiocarps of *T. rutilans*, and since them the name has been erroneously used for collections of *T. osiliensis*, *T. flammula* and *T. decora*. For these reasons we recommend rejecting the name *T. ornata*.

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Ganoderma in Brazil: known species and new records

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Abstract — Eighteen species of *Ganoderma* (*Basidiomycota, Polyporales, Ganodermataceae*) are recorded from Brazil based on specimens deposited at EMBRAPA and SP. Twenty type specimens from Brazil, Belize, Colombia, Cuba, Ecuador, Finland, France, Grenada, Guinea, Mexico, Nicaragua, Panama, USA, and Venezuela were studied in order to establish the proper identity of specimens. Three species (*G. mexicanum*, *G. perzonatum*, *G. pulverulentum*) are new reports for Brazil, *G. weberianum* is recorded for the first time for America, and *G. mexicanum*, *G. perturbatum*, and *G. perzonatum*, are recorded for the first time since their original description. All species with laccate pileus (except *G. vivianimercedianum*) and the non-laccate *G. amazonense* and *G. brownii* are described in detail and illustrated.

Key words — basidiospores, pileipellis cells, taxonomy

Introduction

Ganoderma P. Karst. is a genus with a cosmopolitan distribution, with many tropical species and some restricted to temperate regions. According to Ryvarden (2004) the genus is represented in the neotropics by 20 species, a large number of which are known only from their type locality. Although many *Ganoderma* species have been recorded from Brazil, a tropical country with a great mycological diversity, some have been incorrectly determined and the occurrence of others has not been confirmed. Except for papers by Torrend (1920), Loguercio-Leite et al. (2005) and Gomes-Silva et al. (2011), there have been no detailed studies of *Ganoderma* in Brazil, and taxa not described by them are only recorded in lists, so they have been neither described nor illustrated.

Previous records from Brazil have been listed under the following names: *G. amazonense*, *G. annulare*, *G. applanatum*, *G. australe*, *G. bibadiostriatum*,

G. brownii, *G. citriporum*, *G. chalceum*, *G. colossus*, *G. concinnum*, *G. curtisii*, *G. dorsale*, *G. elegantum*, *G. lobatoideum*, *G. lobatum*, *G. lucidum*, *G. multicornum*, *G. multiplicatum*, *G. multiplicatum* var. *vitalii*, *G. neurosporum*, *G. nitens*, *G. nitidum*, *G. oerstedii*, *G. opacum*, *G. orbiforme*, *G. parvulum*, *G. perturbatum*, *G. pygmoideum*, "*G. reniformis*" [*Elfvingia reniformis*], *G. resinaceum*, *G. sessile*, *G. sessiliforme*, *G. stipitatum*, *G. subamboinense*, *G. subfornicatum*, *G. testaceum*, *G. tornatum*, *G. tropicum*, *G. vivianimercedianum*, and *G. zonatum* (Baltazar & Gibertoni 2009; Bononi et al. 1981, 2008; Da Silva & Minter 1995; de Jesus 1993, 1996; de Meijer 2001, 2006; Drechsler-Santos et al. 2008, 2009; Fidalgo 1968; Furtado 1967; Gerber 1996; Gerber & Loguercio-Leite 1997; Gibertoni & Cavalcanti 2003; Gibertoni & Drechsler-Santos 2010; Góes-Neto 1999; Góes-Neto et al. 2003; Gomes-Silva & Gibertoni 2009; Gomes-Silva et al. 2011; Gottlieb et al. 1998; Gottlieb & Wright 1999a,b; Groposo & Loguercio-Leite 2005; Loguercio-Leite & Wright 1991; Loguercio-Leite et al. 2005; Moncalvo & Buchanan 2008; Patouillard 1889; Rajchenberg & de Meijer 1990; Rick 1960; Ryvarden 2004; Ryvarden & de Meijer 2002; Sotão et al. 1991, 2002; Steyaert 1962, 1980; Torrend 1920; Torres-Torres et al. 2008; Westphalen et al. 2010). Of these, the most commonly reported species are *G. applanatum* and *G. lucidum* sensu lato. As a continuation of the work by Torres-Torres & Guzmán-Dávalos (2005, 2007, 2008) and by Torres-Torres et al. (2008), the goal of the present study is to contribute to the knowledge of *Ganoderma* through reviewing species occurring in Brazil by examining the specimens deposited at SP and EMBRABA herbaria.

Materials & methods

Specimens studied

Materials studied were from EMBRAPA (personal collection of A.A.R. de Meijer) and SP herbaria. Type specimens were requested on loan to herbaria BPI, ENCB, FH, NY, O, PC, and UPS. Herbarium abbreviations follow Holmgren et al. (1990).

Macro and micromorphological observations

Key colors are from Kornerup & Wanscher (1963). Micromorphological observations were made from material mounted in 10% KOH and Melzer's reagent using a 100× oil-immersion objective in Zeiss K7 or Zeiss Axioskop 40 microscope. Basidiospore shape is based on the Q ratio (length/broad ratio; Bas 1969: 320–321) of 20 randomly selected mature basidiospores. Although basidiospores were examined using Axio Vision 4 software with the Zeiss Axioskop 40 microscope with 1600× magnification, the details can also be observed with 1250× magnification).

Main macromorphological features for delimiting species included spongy versus woody basidiomata; pileus crust thickness and hardness; width, color stratification (homogeneous, not fully homogeneous, or duplex), and resinous deposits of the context (Gottlieb & Wright 1999a,b; Steyaert 1980). In duplex context there is an abrupt change,

with two separate, contrasting colors; 'not fully homogeneous' is used when there is an evident but gradual color difference between the upper and lower parts without abrupt color changes. Resinous deposits are hard and brittle substances, which may be dull or shiny and continuous (lines) or discontinuous (incrustations) (Torres-Torres & Guzmán-Dávalos 2012). Main micromorphological features taken into consideration were basidiospore size and apex, disposition and size of basidiospore pillars, and size, shape, and incrustations of the pileipellis cells (Bazzalo & Wright 1982; Gottlieb & Wright 1999a,b; Steyaert 1967, 1980). Basidiospore pillars can be free, subfree, partially anastomosed, or anastomosed. Free pillars appear as independent dots on the basidiospore surface; subfree is when free dots are mixed with two fused pillars or with shortly elongated structures. The term partially anastomosed is used when ≥ two pillars grow together to form an irregular surface. Terms and concepts used in the descriptions are defined in Torres-Torres & Guzmán-Dávalos (2012).

Results

We reviewed Brazilian specimens associated with almost all vegetation types present in Brazil and deposited in EMBRAPA and SP and further checked specimens (including 20 types) deposited in other herbaria. Specifically, four Brazilian type specimens were compared with 16 types from Belize, Colombia, Cuba, Ecuador, Finland, France, Grenada, Guinea, Mexico, Nicaragua, Panama, USA, and Venezuela.

We report 18 *Ganoderma* species from Brazil, including three (*G. mexicanum*, *G. perzonatum*, *G. pulverulentum*) that are new records for Brazil and one (*G. weberianum*) recorded for the first time in America. *Ganoderma mexicanum*, *G. perturbatum* and *G. perzonatum* are recorded for the first time since their original description. An identification key to the *Ganoderma* species studied for this paper is presented. Complete descriptions and illustrations for species with laccate pileus surface (excluding *G. vivianimercedianum,* which was recently described elsewhere) are given; only micromorphological data are provided for all species with dull surfaces, except that *G. amazonense* and *G. brownii* are completely described because both species lack modern descriptions. *Ganoderma applanatum* and *G. australe* are not described because both are quite common and widely covered in the literature (Baltazar & Gibertoni 2009, Gibertoni & Cavalcanti 2003, Loguercio-Leite et al. 2005, Pegler & Young 1973, Steyaert 1975, Tellería 1980).

Key to *Ganoderma* spp. from Brazil studied in this work

1. Pileus dull 2
1. Pileus glossy 5
2. Context brown 3
2. Context pale, not fully homogeneous; basidiospores 7–9 × 5–7 µm, with free pillars ..... *G. amazonense*

3. Pileus crust very hard, generally ≥ 0.5 mm thick; context with resinous bands; basidiospores 8–13 × 6–7 µm 4
3. Pileus crust hard, generally ≤ 0.5 mm thick; context without resinous bands; basidiospores 7–9 × 5–6 µm ..... *G. applanatum*

4. Basidiospores with free, 0.3–0.4 µm thick inter-walled pillars ..... *G. australe*
4. Basidiospores with anastomosed, 0.5–0.8 µm thick inter-walled pillars ... *G. brownii*

5. Basidiomata stipitate; basidiospores with subacute apex 6
5. Basidiomata sessile to stipitate; basidiospores with truncate apex 8

6. Context not fully homogeneous, brown; pileipellis cells without granulations 7
6. Context duplex, light orange or brownish orange above and light brown to brown below; pileipellis cells with or without granulations ..... *G. dorsale*

7. Pileipellis cells entire; basidiospores 10–13 × 8–10 µm ..... *G. perturbatum*
7. Pileipellis cells with up to four protuberances; basidiospores 10–13 × 5–7 µm ..... *G. elegantum*

8. Context pale in general, sometimes with a narrow darker zone towards the tubes 9
8. Context light brown to brown 14

9. Context homogeneous to not fully homogeneous but not duplex; basidiospores 8–10 × 6–7 µm, with free or subfree pillars 10
9. Context duplex; basidiospores 11–14 × 7–9 µm, with free pillars ..... *G. sessile*

10. Context without resinous deposits; pileipellis cells clavate, without granulations ..... *G. sessiliforme*
10. Context with resinous deposits; pileipellis cells cylindrical to narrowly clavate, with granulations 11

11. Pileus surface soft, easy to penetrate with the fingernail 12
11. Pileus surface hard, difficult to penetrate with the fingernail 13

12. Pileipellis cells with concentric elongate granulations in the apex; basidiospores 8–10 × 6–7 µm, with free pillars ..... *G. perzonatum*
12. Pileipellis cells without concentric elongate granulations in the apex; basidiospores 9–12 × 6–8 µm, with subfree pillars ..... *G. vivianimercedianum*

13. Context changing to yellow when cut, not fully homogeneous; basidiospores with subfree pillars ..... *G. weberianum*
13. Context unchanging, homogeneous; basidiospores with free pillars ... *G. parvulum*

14. Context homogeneous; pileipellis cells entire, almost cylindrical to cylindrical; basidiospores 11–13 × 6–7 µm, with free pillars ..... *G. resinaceum*
14. Context not fully homogeneous 15

15. Pileipellis cells entire 16
15. Pileipellis cells with protuberances or branches 17

16. Basidiospores 9–11 × 6–7 µm, with subfree pillars ..... *G. mexicanum*
16. Basidiospores 9–13 × 6–8 µm, with partially anastomosed pillars ..... *G. pulverulentum*

17. Pileipellis cells with up to 14 lateral or apical protuberances; basidiospores 8–10 × 6–7 µm, with free pillars ..... *G. multiplicatum*

17. Pileipellis cells with up to 10 lateral or apical protuberances or branches; basidiospores 9–13 × 6–8 µm 18

18. Pileipellis cells usually with a constriction, generally with ≤5 protuberances and 1–2 branches, apex with ferruginous granulations; basidiospores with free pillars..... *G. subfornicatum*

18. Pileipellis cells irregular, with ≤10 lateral or apical protuberances or branches, without granulations in the apex; basidiospores with subfree pillars ..... *G. orbiforme*

Brazilian species

Ganoderma amazonense Weir, U.S. Dep. Agr. Bull. 1380: 12, 84 (1926).

Basidiomata 7.5–9.5 × 5–9.5 × 2–3 cm, perennial, sessile to substipitate, usually with a narrow base, occasionally imbricate, woody. Pileus round-flabelliform to circular, slightly convex to generally applanate; surface glabrous, bumpy, dull; with a hard crust, difficult to penetrate with the fingernail; surface reddish-brown (8E6); margin white, lobulate, thin. Context 1.5–2 cm thick, fibrous, not fully homogeneous, pale in general, pale orange to light orange (5A3, 5A4) above, gradually changing to light brown (6D7) toward tubes, zonate; without resinous deposits. Pores 3–5 per mm, angular to round, woody; pore surface yellow (3A2) to chrome-yellow (2A8) when fresh, darkening to ochraceous when aging and drying; tubes 0.4–0.5 cm thick, unstratified to stratified, concolorous with the lower part of the context. Hyphal system dimitic. Contextual trama: no generative hyphae were observed; skeletal hyphae 3–5 µm diam., generally solid to thick-walled, non-septate, unbranched, hyaline to light yellow. Pileipellis an irregular crustotrichoderm; hyphal ends impregnated in a resinous substance, entire, solid, golden-yellow. Basidiospores 8–9 × (5–)6–7 µm, Q = 1.23–1.38, widely ellipsoid to ellipsoid, apex truncate, light yellow, inamyloid; perisporium wrinkled, hyaline; exosporium with inter-walled pillars up to 0.3 µm thick, free. Basidia not observed. Cystidia absent.

Habitat: Tropical secondary vegetation, tropical rainforest, plantation of *Hevea brasiliensis*.

Material examined: **BRAZIL, Pará**, Cocal Grande, on *Spondias lutea* in *Hevea brasiliensis* plantation, 20 August 1923, J.R. Weir s.n. (BPI 62043, lectotype). **COLOMBIA, Chocó**, Municipality of Atrato, Yuto, 27 September 2002, M.G. Torres-Torres 131 (XAL, CHOCO), **COSTA RICA, Cartago**, Turrialba, La Central, without date, A. Jiménez s.n. (USJ 66156); **Puntarenas**, Osa, Sierpe, Corcovado National Park, 24 February 2000, E. Fletes 1296 (INB).

Remarks: The remarkable features of *G. amazonense* are its dull pileus, pale context, and small light yellow basidiospores. Although we did not check other materials from Brazil except for the type specimen, we examined collections

Figs. 1-15. Basidiomata of *Ganoderma*. **1**. *G. brownii* (SP214649). **2–3**. *G. dorsale* (SP45190, SP45819). **4**. *G. elegantum* (SP211483). **5**. *G. mexicanum* (SP109514). **6**. *G. multiplicatum* (SP211484). **7**. *G. orbiforme* (SP211911). **8**. *G. parvulum* (NY type). **9**. *G. perturbatum* (SP60278). **10**. *G. perzonatum* (SP50687). **11**. *G. pulverulentum* (SP103257). **12**. *G. resinaceum* (SP61535). **13**. *G. sessiliforme* (SP61432). **14**. *G. subfornicatum* (SP375899). **15**. *G. weberianum* (SP61099). Bar = 1cm.

from Colombia and Costa Rica. Slightly smaller basidiospores were described by Gottlieb & Wright (1999b; 7–8 × 5–6 µm), Ryvarden (2004; 7–8 × 5–6 (–7) µm), and Gomes-Silva et al. (2011; (6–)7–8 × 5–6(–7) µm), while Welti & Courtecuisse (2010) cited measurements (8–9 × 6–7 µm) that agree with ours. *Ganoderma amazonense* has been recorded from other Brazilian localities as well as from several neotropical countries and Africa (e.g., Furtado 1967; Gomes-Silva & Gibertoni 2009; Gomes-Silva et al. 2011; Ryvarden 2004; Steyaert 1980; Welti & Courtecuisse 2010). The Asian records (e.g., Corner 1983) are doubtful (see Welti & Courtecuisse 2010).

Ganoderma applanatum (Pers.) Pat., Hyménomyc. Eur.: 143 (1887) [nom. cons.].

= *Ganoderma lipsiense* (Batsch) G.F. Atk., Ann. Mycol. 6: 189 (1908).

Basidiospores 7–9.6 × 5.6–6.4 µm, Q = 1.4–1.57, ellipsoid, apex truncate, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars 0.3–0.4 µm thick, free.

Habitat: Rain forest, secondary forest.

Material examined: **BRAZIL, Paraná**, Curitiba, São José dos Pinhais, ADEA Reserva Biológica Cambuí, on dead palm trunk, 4 March 1980, A.A.R. de Meijer 386 (EMBRAPA); Antonina, Marumbí, Parque Marumbí, Rio do Nune, on dead dicotyledonous trunk, 12 December 1987, A.A.R. de Meijer 962A (EMBRAPA).

Remarks: A very common species with a wide distribution, *G. applanatum* is characterized by a pileus crust <0.5 mm thick, a context without resinous deposits, and small basidiospores. For a complete description, refer to Kotlaba & Pouzar (1971), and Telleria (1980).

Ganoderma australe (Fr. : Fr.) Pat., Bull. Soc. mycol. Fr. 5: 71 (1889).

≡ *Polyporus australis* Fr. : Fr., Elench. Fung. 1: 108 (1828).

= *Ganoderma tornatum* (Pers.) Bres., Hedwigia 53: 55 (1912).

Basidiospores 8.4–12 × 6–7.2 µm, Q = 1.4–1.57, ellipsoid, apex truncate, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars 0.3–0.4 µm thick, free.

Habitat: Dense ombrophilous forest.

Material examined: **BRAZIL, Paraná**, Curitiba, São José dos Pinhais, ADEA Reserva Biológica Cambuí, 3 February 1979, A.A.R. de Meijer 23 (EMBRAPA); on stump, 15 July 1979, A.A.R. de Meijer 98 (EMBRAPA).

Remarks: The main characteristics of *G. australe* are a very hard pilear crust thicker than 0.5 mm (although young specimens may have a thinner but hard crust) and a context with resinous deposits. *Ganoderma applanatum*differs in smaller basidiospores and a thinner pilear crust. Although a cosmopolitan species, occurrences of *G. australe* are often underestimated because of wrong determinations. Studied specimens agree with the descriptions [some cited as *G. tornatum*] of Gottlieb & Wright (1999b), Kotlaba & Pouzar (1971),

Melo (1986), Núñez & Ryvarden (2000), Pegler & Young (1973), Ryvarden & Johansen (1980), Steyaert (1967, 1975), Tellería (1980); refer to these authors for a complete description.

Ganoderma brownii (Murrill) Gilb., Mycologia 53: 505 (1962 ["1961"]). FIG. 1

BASIDIOMATA 6.5–16 × 6.5–15 × 1.4–2 cm, perennial, sessile, occasionally imbricate, woody. PILEUS round-flabelliform to circular, generally applanate; surface glabrous, bumpy, dull, concentrically sulcate; with a 0.6–0.8 mm thick crust, not cracking, very hard, difficult to penetrate with the fingernail; surface brown (7F7); margin concolorous, entire, thin to thick, obtuse, sulcate. CONTEXT 0.3–0.9 cm thick, fibrous, homogeneous, reddish-brown (9F8), azonate; generally with resinous deposits close to the pileus' base. PORES 4–5 per mm, angular to round, woody; pore surface yellow (3A2) to chrome-yellow (2A8); tubes 0.4–1.5 cm thick, unstratified to stratified, concolorous with the lower part of the context. HYPHAL SYSTEM trimitic. CONTEXTUAL TRAMA: no generative hyphae were observed; skeletal hyphae 3.7–9.3 µm diam., generally solid to thick-walled, non-septate, arboriform, yellowish-brown; no binding hyphae were observed. PILEIPELLIS a crustotrichoderm; terminal elements 6.8–9.3 µm wide, with apex 7–10 µm wide, entire, solid, golden-yellow. BASIDIOSPORES 9.3–11.2 × 6.6–7.4 µm, Q = 1.25–1.5, widely ellipsoid to ellipsoid, apex truncate, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars 0.5–0.8 µm thick, anastomosed. BASIDIA not observed. CYSTIDIA absent.

HABITAT: Atlantic dense ombrophilous rain forest.

MATERIAL EXAMINED: **USA, CALIFORNIA**, Strawberry Canyon, on dead *Umbellularia*, November 1910, V.S. Brown 307 (NY, lectotype). **BRAZIL, SÃO PAULO**, Reserva Biológica de Paranapiacaba, 25 August 1987, M. Capelari 1723 (SP214649).

REMARKS: This species is characterized by its very hard, >0.5 mm thick pileus crust, reddish-brown context, yellow pore surface, and large broadly ellipsoid to ellipsoid basidiospores. Although Gilbertson & Ryvarden (1986) suggest that *G. brownii* is restricted to California, the Brazilian specimen agrees with the lectotype, which has basidiospores 9–12 × 6.5–8 µm. As Bononi et al. (2008) recorded the species from Mato Grosso do Sul, this represents a second record for Brazil. Gottlieb & Wright (1999b) cite *G. brownii* as a synonym of *G. lipsiense,* but we consider *G. applanatum*/*G. lipsiense* as separate (cf. the two descriptions).

Ganoderma dorsale (Lloyd) Torrend, Brotéria, sér. Bot. 18: 32 (1920). FIGS 2–3, 16–17

= *Ganoderma concinnum* Ryvarden, Mycologia 92: 183 (2000).

BASIDIOMATA 2–5.5 × 3–10 × 0.5–1.5 cm, annual, stipitate, woody-corky. PILEUS round-flabelliform to reniform, convex to generally applanate; surface glabrous, bumpy, semiglossy to glossy, concentrically sulcate; with a laccate

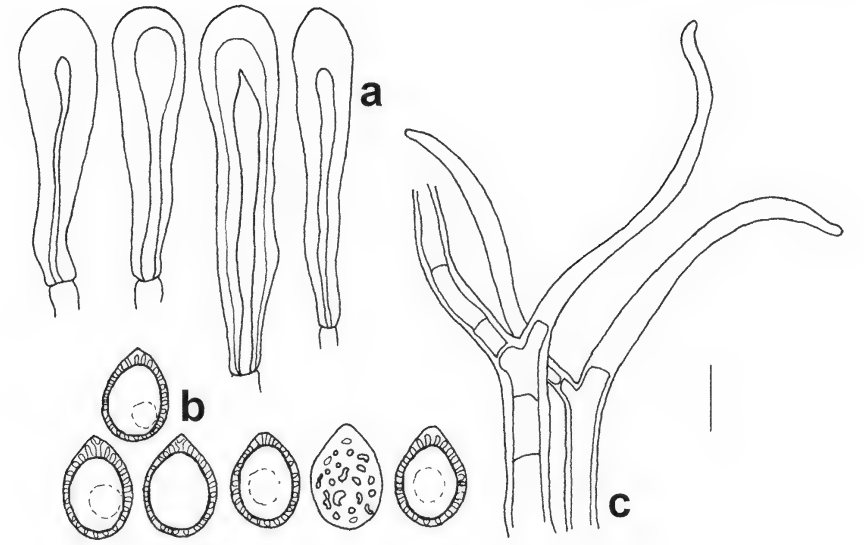

Fig. 16. *Ganoderma dorsale* (SP45190). Bar = 8 μm.
a. Pileipellis cells. **b**. Basidiospores. **c**. Skeletal hyphae of crustohymeniderm.

crust, not cracking, difficult to remove, easy to penetrate with the fingernail; surface garnet-red (11E8) or violet-brown (11F8), almost homogeneous in the adult; margin yellowish to concolorous, entire, acute to obtuse, smooth to sulcate. Stipe 3.5–10 × 0.3–1.5 cm, lateral, cylindrical, solid, context duplex as basidiomata context; surface smooth to tuberculate, generally very shiny, red-wine almost black, generally darker than the pileus. Context 0.2–0.6 cm thick, up to 1.2 cm in pileus' base, fibrous, duplex, pale-orange to light-orange (5A3, 5A4) to brownish orange or caramel (6C6) above, brown (lighter than 6F8) to light brown (6D7) toward tubes, azonate; generally with resinous bands very thin and inconspicuous, only one specimen with thick lines; stipe context also duplex. Pores 4–8 per mm, angular to round, woody; pore surface yellow (3A2); tubes 0.1–0.7 cm thick, unstratified, concolorous with the lower part of the context. Hyphal system trimitic. Contextual trama: no generative hyphae were observed; skeletal hyphae 3.1–12 μm diam., solid to generally thick-walled, apex septate, arboriform, yellow to yellowish-brown; binding hyphae 1.9–3.1 μm diam., thick to solid, non-septate, yellowish, scarce. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 46–72 × 7.2–13.6 μm, narrowly clavate to clavate, entire or with one lateral protuberance; thick-walled, golden-brown, with or without granulations in the apex; dextrinoid. Basidiospores 11.8–14 × 8–9.3(–10) μm, Q = 1.4–1.65, ellipsoid, apex subacute, yellowish-brown, inamyloid; perisporium wrinkled,

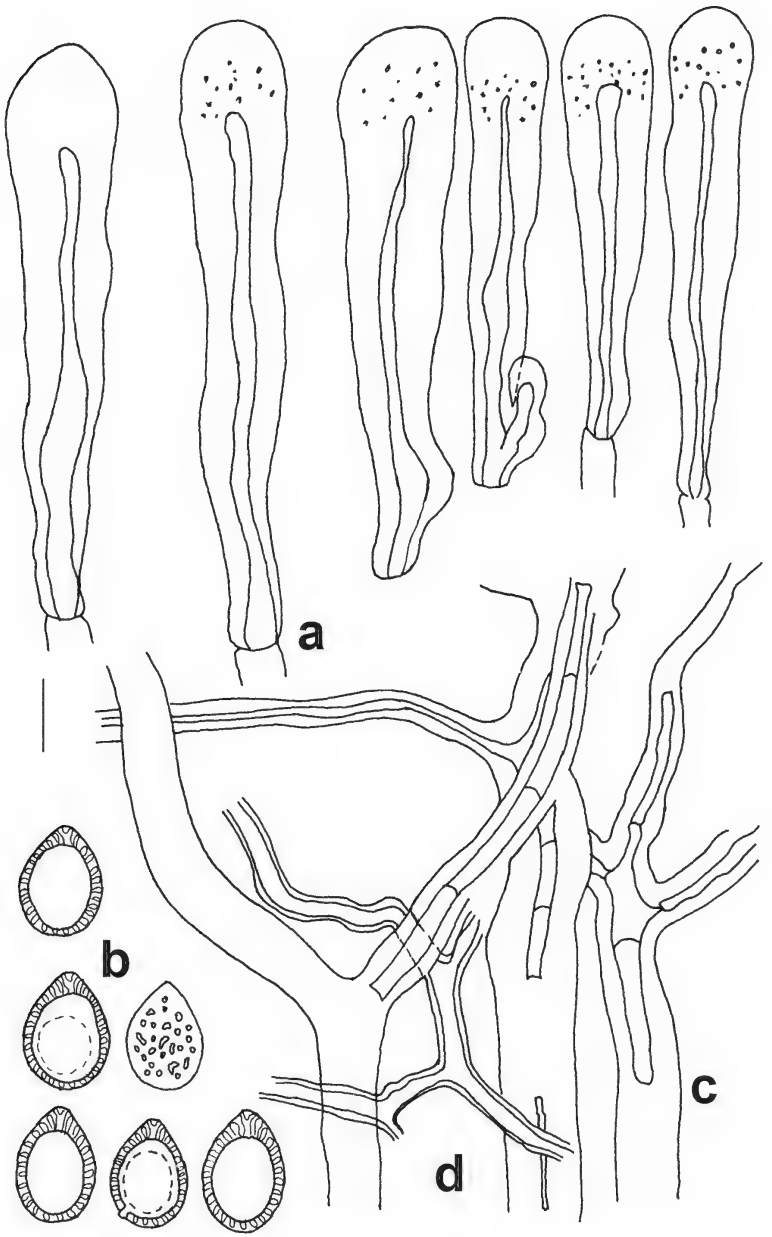

Fig. 17. *Ganoderma dorsale* (SP45819). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores.
c–d. Crustohymeniderm: **c**. Skeletal hyphae. **d**. Binding hyphae.

reddish-brown; exosporium with inter-walled pillars 0.5–0.6 µm thick, partially anastomosed; with apical germ pore difficult to observe. Basidia not observed. Cystidia absent.

Habitat: Seasonal semi-deciduous forest, seasonal semi-deciduous submontane forest, seasonal semi-deciduous alluvial forest, tropical rain forest.

Material examined: **BRAZIL**, **Rio Grande do Sul**, on buried wood, without date, R.J. Rick s.n. (BPI 303197, holotype); **Paraná**, Curitiba, Centro Politécnico, Jardim das Americas, on buried roots of living dicotyledonous tree, 18 January 1989, A.A.R. de Meijer 1194 (EMBRAPA); Parque Boriquí, on soil, 5 March 1993, A.A.R. de Meijer 2533 (EMBRAPA); Reserva Biológica Cambuí, on forest soil, 24 November 1994, A.A.R. de Meijer 2961 (EMBRAPA); Reserva Biológica Cambuí, on buried dicotyledonous, 20 May 1995, A.A.R. de Meijer 2278 (EMBRAPA); Jundiaí do Sul, Fazenda Monte Verde, on decayed dicotyledonous, on buried wood, 4 February 1996, A.A.R. de Meijer 3253 (O, EMBRAPA); **Rio Grande do Sul**, Pelotas, Horto Florestal, buried, 9 June 1959, E.C. Santos 29 (SP45190); **São Paulo**, Iepe, about 5 km of Porto Alvarado, along of the Rio Paranapanema, Fazenda CAPI, 9 February 1965, G. Eiten, L.T. Eiten & H. Kimura 6009 (SP102607). **COLOMBIA**, **Chocó**, Municipality of Riosucio, Sautatá, Parque Nacional Katios, 28–30 June 1978, L. Ryvarden 18640 (O, holotype of *G. concinnum*).

Remarks: *Ganoderma dorsale* is characterized by its stipitate basidiome, duplex context, and basidiospores with subacute apex. Examined specimens agree with the holotype and with the description by Gottlieb & Wright (1999a, as "*Ganoderma lucidum* var. *dorsale*"). Although Moncalvo & Ryvarden (1997) reported this species as common in Brazil and recorded it also from Malaysia and Philippines, it was not included in the most recent treatment of neotropical polypores (Ryvarden 2004). Baltazar & Gibertoni (2009) reported it from the Brazilian Atlantic forest. The species was considered a synonym of *G. perturbatum* by Steyaert (1967) and of *G. lucidum* s.l. by Ryvarden (1990). The two specimens in SP (SP45190, SP102607) were labeled *G. lucidum* and possibly published under the same name. *Ganoderma concinnum* is considered a synonym of *G. dorsale* because it also has a stipitate basidiome, duplex context, and basidiospores with subacute apex. The only differences found are granulations of the pileipellis cells and absence of resinous bands in the context in *G. dorsale*, not enough to support two separate species. Ryvarden (2000) suggested that the long stipe distinguished *G. dorsale* from *G. concinnum*; however, there are specimens with very short stipes that agree well with the *G. dorsale* concept (e.g., SP45190 and SP102607). Moreover, Ryvarden (2000) described larger (12–14 × 7–8 µm) basidiospores than we measured (8–10 µm wide) in the *G. concinnum* holotype. *Ganoderma concinnum* has been recorded from Brazil by Baltazar & Gibertoni (2009), de Meijer (2006), and Ryvarden & de Meijer (2002). *Ganoderma perturbatum,* which is also stipitate and produces basidiospores with a subacute apex and partially anastomosed pillars, is otherwise easily distinguished (cf. *G. perturbatum*).

Ganoderma elegantum Ryvarden, Syn. Fung. 19: 81 (2004). FIGS 4, 18

BASIDIOMATA 1.7 × 2 × 1 cm, annual, stipitate, woody-corky. Pileus round-flabelliform, applanate; surface glabrous, glossy, concentrically sulcate; with a laccate crust, not cracking, easy to penetrate with the fingernail; surface

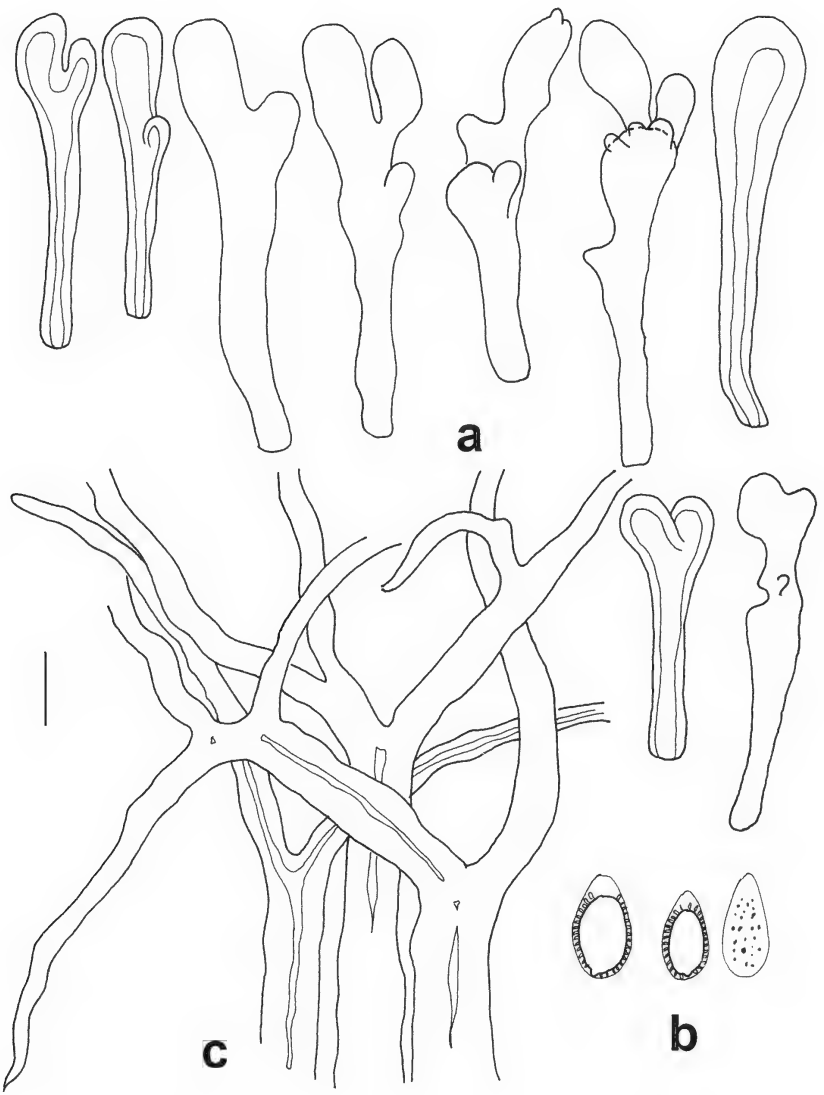

FIG. 18. *Ganoderma elegantum* (SP211483). **a**. Pileipellis cells. **b**. Basidiospores. **c**. Crustohymeniderm: skeletal hyphae.

homogeneous reddish-brown (11F8); margin whitish, entire, obtuse to acute, smooth. Stipe 8.7 × 1.3 cm, lateral, cylindrical, solid; surface smooth, very shiny, red-wine almost black, darker than pileus. Context 0.9 cm thick, spongy-fibrous, not fully homogeneous, yellowish-brown (5E8) to eye-brown (7F7), azonate; with resinous bands that do not extend up to the margin. Pores 6–7 per mm, angular to round, woody; pore surface yellowish (2A3); tubes 0.1 cm thick, unstratified, concolorous with the lower part of the context. Hyphal system dimitic. Contextual trama: no generative hyphae were observed; skeletal hyphae 2.5–8.7 µm diam., solid to generally thick-walled, non-septate, arboriform, yellow to yellowish-brown. Hymenophoral trama: no generative hyphae were observed; skeletal hyphae 2.5–6.2 µm diam., solid to generally thick-walled, non-septate, arboriform, yellow to yellowish-brown. Pileipellis a crustohymeniderm, cells 29.8–52.7 × 6.2–10.5 µm, clavate, entire or with up to six lateral or apical branches or protuberances; subthick-walled, golden-yellow, without granulations in the apex; negative or apex slightly amyloid. Basidiospores 10–12 × 5–7 µm, Q = 1.4–1.65, oblong to ellipsoid, apex subacute, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars up to 0.3 µm thick, subfree; endosporium wrinkled; with apical germ pore difficult to observe. Basidia not observed. Cystidia absent.

Habitat: Amazonian rain forest.

Material examined: **ECUADOR**, Yasuni National Park, Yasuni Scientific Reserve, on dead hardwood log, 12 March 2002, Ryvarden 44573 (O, holotype). **BRAZIL**, **Rondônia**, Jarú, near the airport, on wood, 10 October 1986, M. Capelari & R. Maziero 962 (SP211483).

Remarks: *Ganoderma elegantum* was recently described from Ecuador (Ryvarden 2004) and recorded in a checklist from Brazilian Amazonia by Gomes-Silva & Gibertoni (2009; based on a specimen determined by Torres-Torres in 2005). Although the Brazilian specimen cited above has many immature basidiomata with few basidiospores, the features agree in general with the holotype. Ryvarden (2004) described apically widened pileipellis cells without protuberances, but we observed up to six lateral or apical branches or protuberances per cell in both the holotype and Brazilian specimens.

Ganoderma mexicanum Pat., Bull. Soc. mycol. Fr. 14: 54 (1898). Figs 5, 19

Basidiomata 6.2–11.2 × 9–19 × 1.6–2.5 cm, annual, sessile, woody, but light in weight when dry. Pileus round-flabelliform to semicircular, convex to applanate; surface glabrous, rugose, semiglossy; with a laccate crust, thin, not easily cracked or removed, but easy to penetrate with the fingernail, concentrically sulcate; surface reddish-black in a 80% of the surface to brown-violet (11F5) towards the margin, almost homogeneous; margin henna (7E8) to concolorous with the pileus, slightly lobulate, thin to thick, obtuse, smooth.

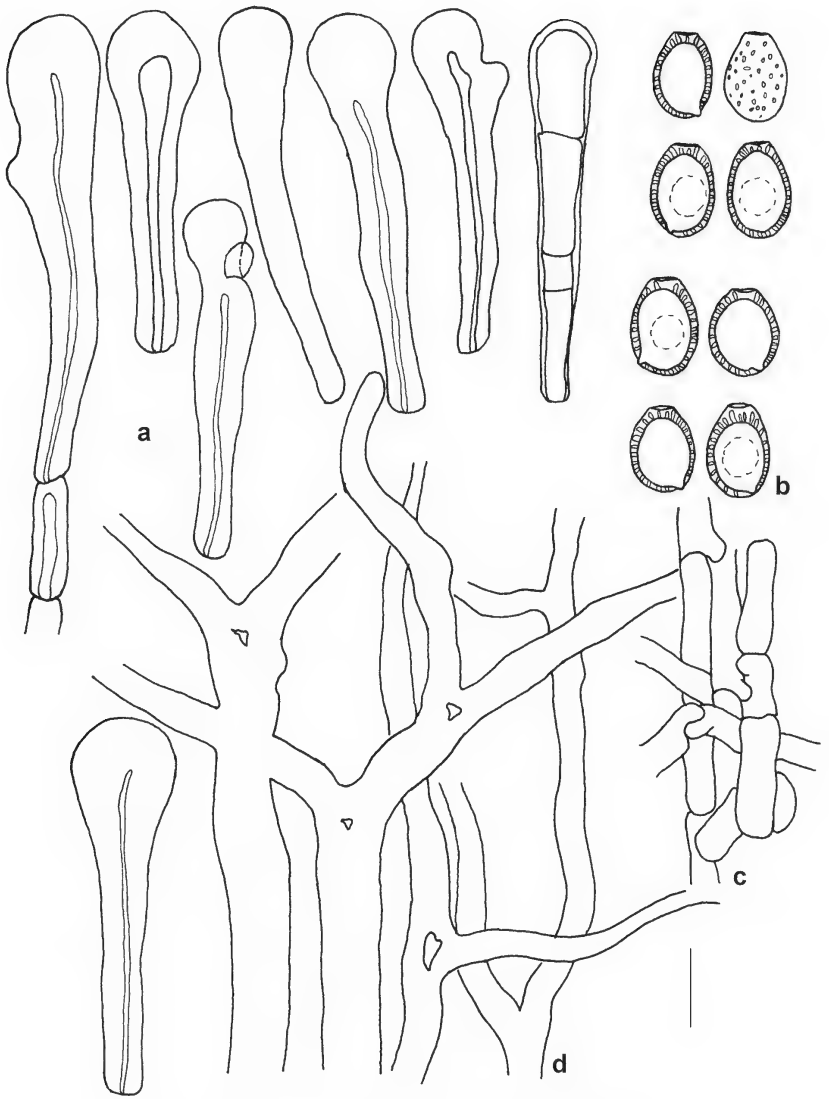

Fig. 19. *Ganoderma mexicanum* (SP109514). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores.
c–d. Crustohymeniderm: **c**. Generative hyphae. **d**. Skeletal hyphae.

Context 0.4–0.8 cm thick, fibrous, not fully homogeneous, pale-orange to light brown (5A3, 5B6) in the upper portion, brown or cognac (6E7) toward the tubes, azonate; with resinous bands up to half of the context. Pores 3–5

per mm, round, woody; pore surface pale yellow (2A3); tubes 0.8–1.1 cm thick, unstratified, concolorous with the lower part of the context. Hyphal system dimitic. Contextual trama: generative hyphae 1.8–5 µm diam., thin-walled, hyaline, non-branched; skeletal hyphae 1.9–9.3 µm diam., thick-walled to generally solid, non-septate, arboriform, yellowish. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 35.2–72.4 × 6.8–10.5 µm, clavate to narrowly clavate, some apically widened, entire or rarely with one lateral protuberance; very thick-walled, golden-brown to yellowish-brown, without granulations in the apex; dextrinoid. Basidiospores 9.3–10.6 × 6.2–7.4 µm, Q = 1.42–1.54, ellipsoid, apex truncate, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars 0.3 µm thick, subfree. Basidia not observed. Cystidia absent.

Habitat: Not specified.

Material examined: **MEXICO, Estado de México**, D. de Jonacatepec, Tepalcingo, 22 October 1890, s. coll. (FH, lectotype). **BRAZIL, São Paulo**, Tremembé, Horto Florestal de Cantareira, on trunk of *Araucaria angustifolia*, 3 March 1953, C.D.F. Pacheco s.n. (SP109514).

Remarks: The most important features of *G. mexicanum* are a not fully homogeneous context, apically widened pileipellis cells, and small basidiospores with subfree pillars. The studied specimen agrees with the lectotype, which, however, "seems" to have a homogenous context without resinous bands. A possible explanation is that the type is poorly conserved with most of the context destroyed. This species was previously known only from the type locality (Patouillard 1898). This is the second record of the species for the world.

Ganoderma multiplicatum (Mont.) Pat., Bull. Soc. mycol. Fr. 5: 74 (1889). Figs 6, 20

Basidiomata 5–7 × 4–12 × 1–3 cm, perennial, sessile to substipitate, woody. Pileus round-flabelliform with a contracted base, slightly convex to applanate; surface glabrous, smooth to bumpy, glossy; with a laccate crust, thin, not easily cracked or removed, but easy to penetrate with the fingernail, concentrically sulcate; surface very dark reddish-black to dark violet-brown (11F5) in 80–90% of the pileus, the remaining area rust-brown (6E8) to dark orange (5B8); margin whitish, entire to slightly lobulate, obtuse, smooth. Context 0.6–0.9 cm thick, fibrous, not fully homogeneous, light yellowish-brown changing to light brown (6D7) toward the tubes, zonate; with resinous bands. Pores 4–6 per mm, angular to round, woody; pore surface pale yellow (2A3); tubes 0.4–0.8 cm thick, unstratified, concolorous with the lower part of the context. Hyphal system dimitic. Contextual trama: no generative hyphae were observed; skeletal hyphae 3.8–7.5 µm diam., subthick-walled to generally solid, non-septate, arboriform, yellow. Hymenophoral trama: generative hyphae 2–3.8 µm diam., thin-walled, hyaline, abundant; skeletal hyphae

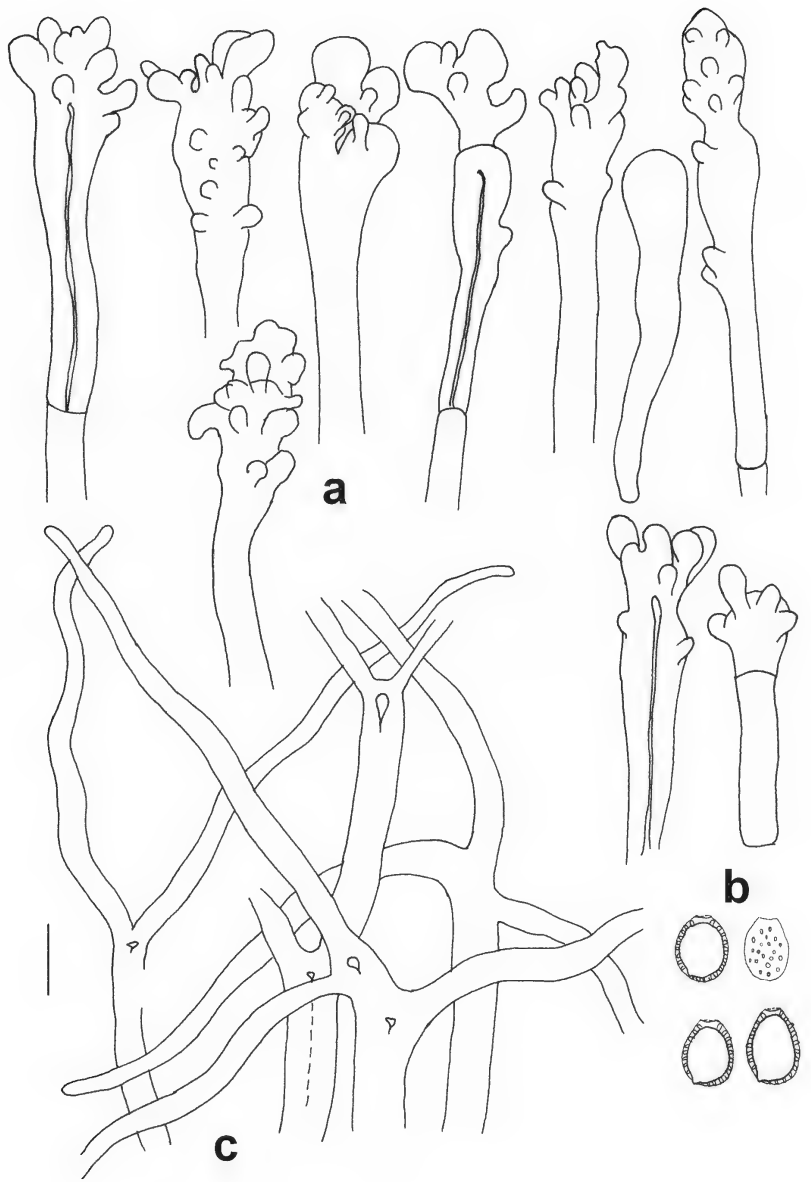

Fig. 20. *Ganoderma multiplicatum* (SP211484). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores.
c. Crustohymeniderm: skeletal hyphae.

2.2–3.8 µm diam., subthick-walled to generally solid, non-septate, arboriform, yellow to yellowish-brown. Pileipellis a crustohymeniderm, cells 38.5–62 × 5.6–10 µm, clavate, narrowly clavate or irregular, with up to 14 lateral or apical protuberances; very thick-walled, golden-yellow, without granulations in the apex; amyloid. Basidiospores 8–9.9 × 6.2–6.8 µm, Q = 1.3–1.47, ellipsoid, apex truncate, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars up to 0.3 µm thick, free. Basidia not observed. Cystidia absent.

Habitat: Atlantic rain forest, Amazonian rain forest.

Material examined: **BRAZIL**, **Alagoas**, Maceió, Reserva do Ibama, 28 August 1992, R. Maziero s.n. (SP250605); **Rio de Janeiro**, Mata de Tijuca, 4 May 1966, J.S. Furtado s.n. (SP91404); **Rondônia**, Jarú, right margin of Rio Jarú, 3 October 1986, M. Capelari & R. Maziero 693 (SP211484); **São Paulo**, Parque do Estado, Instituto de Botânica, on wood, 23 January 1970, B. Skvortzov s.n. (SP10746); **Sergipe**, Estação Ecológica Santa Isabel, 9 December 2003, R.H. Marino s.n. (SP375895).

Remarks: *Ganoderma multiplicatum* is characterized by a reddish-black pileus, a not fully homogenous context, small basidiospores, and pileipellis cells with many protuberances. The cited specimens agree with Gottlieb & Wright (1999a) and Ryvarden (2000, 2004), except that the last author described pileipellis cells lacking or with only a few small apical protuberances. However, Gottlieb & Wright (1999a) described pileipellis cells in the type as "elongated acanthophysis-like elements," and the cells we found in the Brazilian specimens are very similar to their illustrations. This species was described from French Guiana and recorded from Angola, Argentina, Brazil, India, Indonesia, Ivory Coast, Seychelles, Sierra Leone, Zaire and Zambia (Baltazar & Gibertoni 2009; Gomes-Silva & Gibertoni 2009; Gomes-Silva et al. 2011; Gottlieb & Wright 1999a; Ryvarden 2000; Steyaert 1980). According to Ryvarden (2000), it has a pantropical distribution. Some EMBRAPA and SP specimens were labeled *G. lucidum*.

Ganoderma orbiforme (Fr.) Ryvarden, Mycologia 92: 187 (2000). Figs 7, 21

Basidiomata 4–6.5 × 5–8 × 1.5–2 cm, perennial, sessile, occasionally imbricate, woody. Pileus round-flabelliform, convex to applanate; surface glabrous, bumpy, glossy; with a laccate crust, thin, not easily cracked or removed, but easy to penetrate with the fingernail, concentrically sulcate; surface very dark reddish-black in 80–90% of the surface to light-brown (6D8) toward the margin; margin light-brown (6D8), entire, obtuse, generally sulcate. Context 0.8–1 cm thick, fibrous, not fully homogeneous, light golden-brown (5D) to rust-brown (6E8) toward the tubes, zonate; with discontinuous resinous bands. Pores 4–8 per mm, round, woody; pore surface yellow (3A6); tubes 0.7–0.9 cm thick, unstratified to stratified, concolorous with the lower part of the context. Hyphal system trimitic. Contextual trama: no generative hyphae

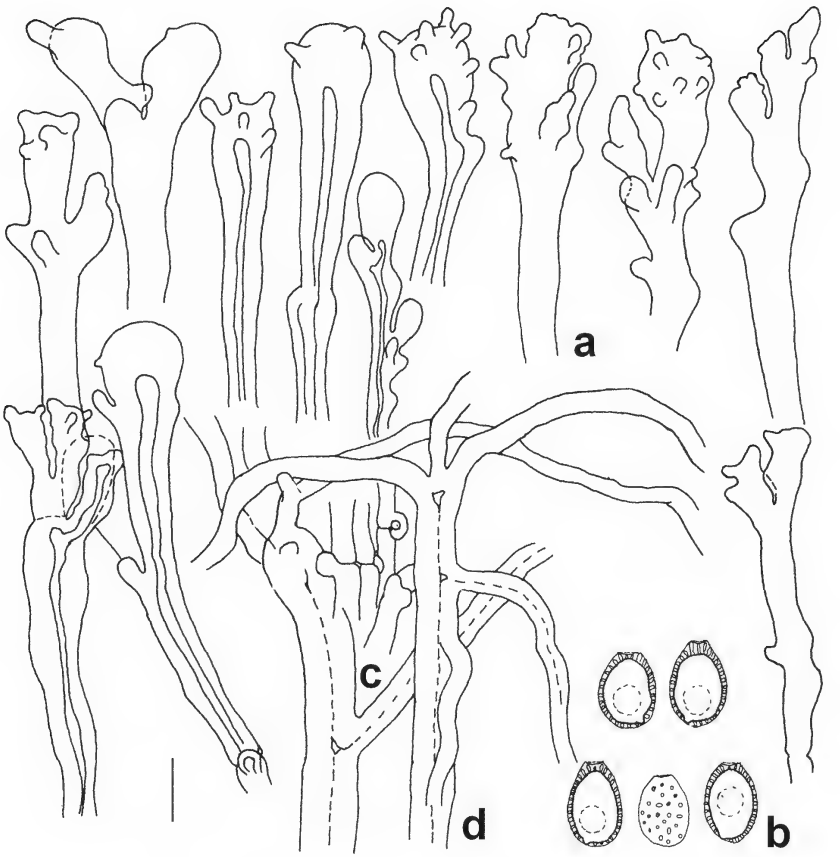

Fig. 21. *Ganoderma orbiforme* (SP211911). Bar = 8 μm.
a. Pileipellis cells. **b**. Basidiospores.
c–d. Crustohymeniderm: **c**. Generative hyphae. **d**. Skeletal hyphae.

were observed; skeletal hyphae 2.5–8.8 μm diam., generally solid, non-septate, arboriform, yellow to yellowish-brown. Hymenophoral trama: generative hyphae 2.5–5 μm diam., thin-walled, hyaline, branched; skeletal hyphae 2.5–8 μm diam., generally solid, non-septate, arboriform, golden-yellow to yellowish-brown; binding hyphae 1.9–2.5 μm, thick-walled, hyaline to yellowish, scarce. Pileipellis a crustohymeniderm, cells 33.5–62 × 4.4–9.3 μm, irregular, with up to 10 lateral or apical protuberances or branches; thick-walled, golden-yellow to golden-brown, without granulations in the apex; strongly amyloid. Basidiospores 9–11.2(–13) × 6.9–8(–8.6) μm, Q = 1.38–1.5, ellipsoid, apex truncate, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown;

exosporium with inter-walled pillars 0.4–0.5 µm thick, subfree. Basidia not observed. Cystidia absent.

Habitat: Atlantic rain forest, artificial *Pinus* forest.

Material examined: **GUINEA**, without data, A. Afzelius s.n. (UPS, holotype). **BRAZIL**, **Rio de Janeiro**, Angra de Reis, Ilha da Gilpoia, 4 March 1956, O. Fidalgo F-365 (SP95346); **Paraná**, Paranaguá, Ilha do Mel, on dead standing trunk of *Ocotea pulchella*, 6 May 1989, A.A.R. de Meijer 1234 (EMBRAPA); **São Paulo**, Água Funda, Secretaria de Agricultura, on trunk of *Pinus* sp., 31 March 1986, M.A. de Jesus s.n. (SP211911); Trilha do Jardim Botânico de São Paulo, 12 February 2004, A.M. Gugliotta & G.R. Leal 1205 (SP382045).

Remarks: *Ganoderma orbiforme* is characterized by a very dark (almost black) pileus, not fully homogenous context, pileipellis cells with many protuberances and branches, and basidiospores with subfree pillars. The Brazilian specimens agree with the holotype, although it comprises only one poorly conserved basidiome with only rust-brown (6E8) context remnants, from which it is impossible to elucidate structure or presence of resinous bands. Ryvarden (2000, 2004) described broadly ellipsoid basidiospores, but this shape agrees with neither his measurements (10–11 × 6–7 µm) nor the ellipsoid basidiospores of the type specimen (9–11 × 7–8 µm). *Ganoderma orbiforme* is morphologically similar to *G. multiplicatum,* but the latter has smaller basidiospores (8–9.9 × 6.2–6.8 µm) with free pillars and pileipellis cells with only short protuberances. Although recorded from the states of Amazonas and Paraná, Brazil by de Meijer in 2006 (Baltazar & Gibertoni 2009), Gomes-Silva et al. (2011), and Ryvarden & de Meijer (2002), *G. orbiforme* probably has a wider tropical distribution. We record this species from the states of Rio de Janeiro and São Paulo here for the first time.

Ganoderma parvulum Murrill, Bull. Torrey bot. Club. 29: 605 (1902). Figs 8, 22

= *Ganoderma stipitatum* (Murrill) Murrill, N. Amer. Fl. 9: 122 (1908).

Basidiomata 1.7–5.5 × 2.2–4 × 0.7–1.3 cm, annual, substipitate to sessile, with a contracted base, occasionally imbricate, woody. Pileus semicircular, round-flabelliform to flabelliform, convex to applanate; surface glabrous, rivulose to slightly radially rugose, hard, glossy to dull; with a laccate crust, not cracked, hard (difficult to penetrate with the fingernail), but easily lost and then leaving the surface relatively homogeneously dull, zonate; surface reddish-black to violet-brown (11F4) in 80–90% of the pileus, reddish-brown (9E8) towards the margin; margin pure white or yellowish, entire to slightly lobulate, thin, smooth. Substipe when present 0.9–1.5 × 1–1.5 cm, short and thick, thinner toward the base, horizontal, slightly darker than pileus, solid. Context 0.4–0.8 cm thick, fibrous, homogeneous, cream (4A3), azonate; with resinous dark bands up to half of the context. Pores 5–6 per mm, round, woody; pore surface yellowish-white (3A2) to light yellow (4A4) when fresh,

darkening to ochraceous or yellowish-brown (6E8) when aging and drying; tubes 0.2–0.4 cm long, unstratified, dark brown contrasting with the context. Hyphal system dimitic. Contextual trama: generative hyphae 2.4–5.6 µm diam., thin-walled, with conspicuous clamps, non-branched, hyaline to yellowish; skeletal hyphae 5.6–12 µm diam., thick-walled to generally solid, septate to non-septate, arboriform with few branches, moderately branched, golden-yellow. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 48–60 × 7.2–9.6 µm, cylindrical to narrowly clavate, entire or rarely with one lateral protuberance, thick-walled to solid, apex with granulations, golden-yellow, amyloid. Basidiospores 8–9 × 6–6.8 µm, Q = 1.18–1.38, broadly ellipsoid, apex truncate, with apical germ pore, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars up to 0.3 µm thick, free; endosporium wrinkled. Basidia not observed. Cystidia absent. Chlamydospores 9.6–10.5 µm, globose, thick-walled, with inter-walled very thick pillars, yellow.

Habitat: Frondose forest, mixed ombrophilous alluvial forest.

Material examined: **NICARAGUA**, without data, C.L. Smith s.n. (NY, lectotype of *G. parvulum*; BR, isolectotype); without data, C.L. Smith s.n. (NY, lectotype of *G. stipitatum*; BR, isolectotype). **BRAZIL**, **Paraná**, Curitiba, São José dos Pinhais, ADEA-reserve, Reserva Biológica Cambuí, on decayed tree, 7 July 1979 A.A.R. de Meijer 91 (EMBRAPA); 10 June 1987, A.A.R. de Meijer 850 (EMBRAPA); on dead dicotyledonous trunk, 14 December 1989, A.A.R. de Meijer 1418 (EMBRAPA).

Remarks: *Ganoderma parvulum* may be recognized by its generally small basidiomata, hard pileus crust, resinous dark bands contrasting with the pale context, cylindrical pileipellis cells with apical granulations, and small basidiospores with free pillars. The species is morphologically similar to *G. perzonatum* and *G. weberianum*, but *G. perzonatum* has larger basidiomata, a soft pilear laccate crust (easy to penetrate with the fingernail), a not fully homogeneous context, and pileipellis cells with concentric elongate granulations while *G. weberianum* has a not fully homogeneous context that changes to yellow when cut and basidiospores with subfree pillars. In his description of *G. parvulum*, Ryvarden (2000, 2004) reported "the lower part of context dark brown, darker than the intermediate and upper paler brown parts," which, in our terminology, is the equivalent to a not fully homogenous context. He also noted pileipellis cells without incrustations. He synonymized *G. parvulum* with *G. stipitatum*, recorded by him for Brazil (Ryvarden 2000). We agree with Ryvarden (2004) that they are synonyms, but the name *G. parvulum* has priority over *G. stipitatum*. Steyaert (1980) cited a wrong reference for the *G. parvulum* protologue ("North. Am. Fl. 9: 13, 1908"), and this was apparently followed by Ryvarden (2004). Ryvarden (2004) cited *G. stipitatum* from Bolivia, Brazil, Costa Rica, Nicaragua, Peru, Suriname, and Venezuela, but some of the cited specimens have a dark brown context and larger basidiospores and may

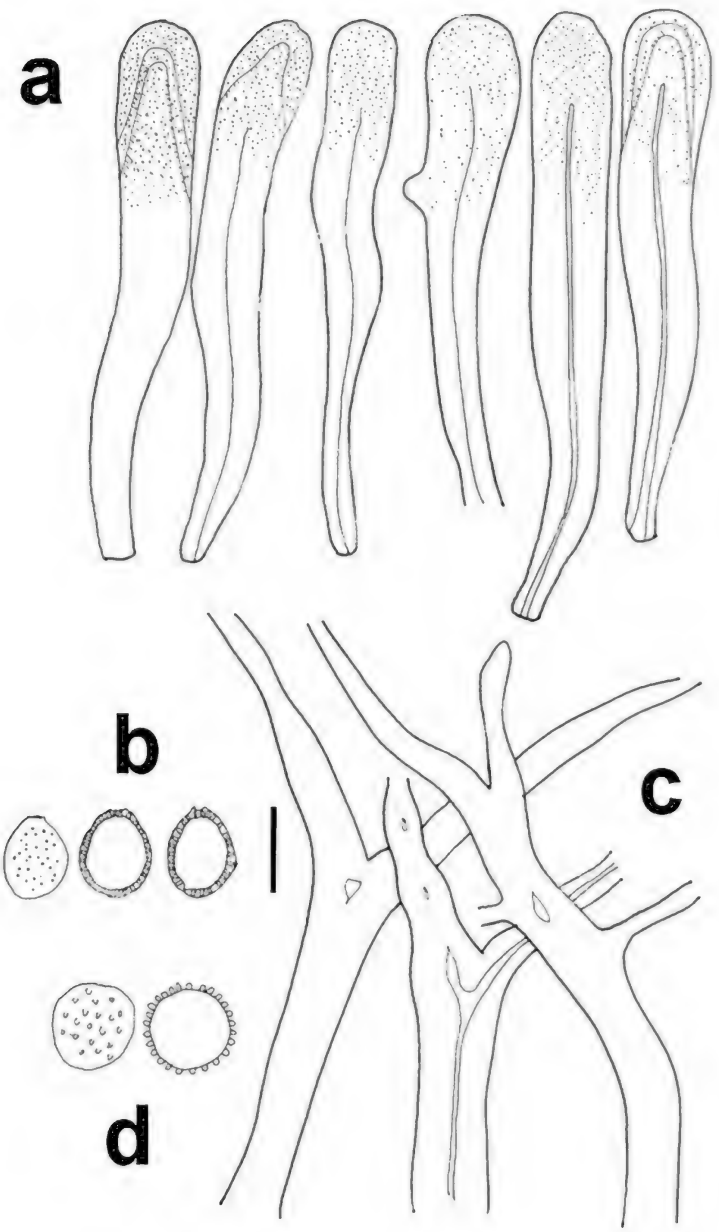

FIG. 22. *Ganoderma parvulum* (NY type). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores.
c. Crustohymeniderm: skeletal hyphae. **d**. Chlamydospores.

represent another species (unpublished observations by M.G. Torres-Torres). Gomes-Silva et al. (2011) and Welti & Courtecuisse (2010) cited this species (as *G. stipitatum*) from Brazil, Belize, and French Guiana. The specimens from USA (NY) noted by Welti & Courtecuisse (2010) and revised by Torres-Torres in 2008 correspond to *G. parvulum* [= *G. stipitatum*]. Rajchenberg & de Meijer (1990) cited *G. parvulum* from Paraná, Brazil (specimen de Meijer 850); but Ryvarden & de Meijer (2002) reported de Meijer 850 and 1418 as *G. resinaceum*. Our examinations show both collections to be very different from *G. resinaceum* and with the cream context and smaller basidiospores that corresponds to *G. parvulum*.

Ganoderma perturbatum (Lloyd) Torrend, Brotéria, sér. Bot. 18: 34 (1920). Figs 9, 23

Basidiomata 4 × 5 × 1.2 cm, perennial, stipitate, woody-corky, light in weight. Pileus reniform, convex; surface glabrous, bumpy, semiglossy to glossy, concentrically sulcate; with a laccate crust, not cracking, difficult to remove, easy to penetrate with the fingernail; surface almost homogeneous violet-brown (darker than 11F7 or 11F8); margin whitish to yellow, entire, obtuse, sulcate. Stipe 4.7 × 1 cm, lateral, cylindrical, solid, very dark violet-brown (11F8) to black, concolorous to generally darker than pileus; surface smooth to tuberculate, shiny, red-wine almost black, darker than pileus. Context 0.4 cm thick, fibrous, not fully homogenous, raw-sienna or light brown (6D7), to slightly darker next to the tubes, azonate; resinous incrustations not very visible. Pores 3–4 per mm, angular to round, woody; pore surface yellow (3A2); tubes up to 0.8 cm thick, stratified, concolorous with the lower part of the context. Hyphal system trimitic. Contextual trama: generative hyphae 3.2 µm diam., thin-walled, hyaline, scarce; skeletal hyphae 2.5–7.5 µm diam., generally solid to thick-walled, non-septate to septate in the apex near to the pileipellis, arboriform, golden-yellow; binding hyphae 1.9–2.2 µm diam., thick-walled, yellowish, scarce. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 43.5–83.8 × 6.2–14.9 µm, clavate to narrowly clavate, entire or rarely with one lateral protuberance or branch; thick-walled, multistratified, golden-brown, without granulations in the apex; slightly amyloid. Basidiospores (9.9–)10.8–12.4(–13) × 8–9.3(–9.9) µm, Q = 1.14–1.43, broadly ellipsoid to ellipsoid, few subglobose, apex subacute, with apical germ pore difficult to observe, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars 0.5–0.6 µm thick, partially anastomosed. Basidia not observed. Cystidia absent.

Habitat: Not specified.

Material examined: **BRAZIL, Rio Grande do Sul**, Lageado, without date, R. Rick s.n. (BPI, holotype); Santa Maria, Distrito de Boca do Monte, on dead buried wood, 22 April 1961, J.P. da Costa Neto s.n. (SP60278).

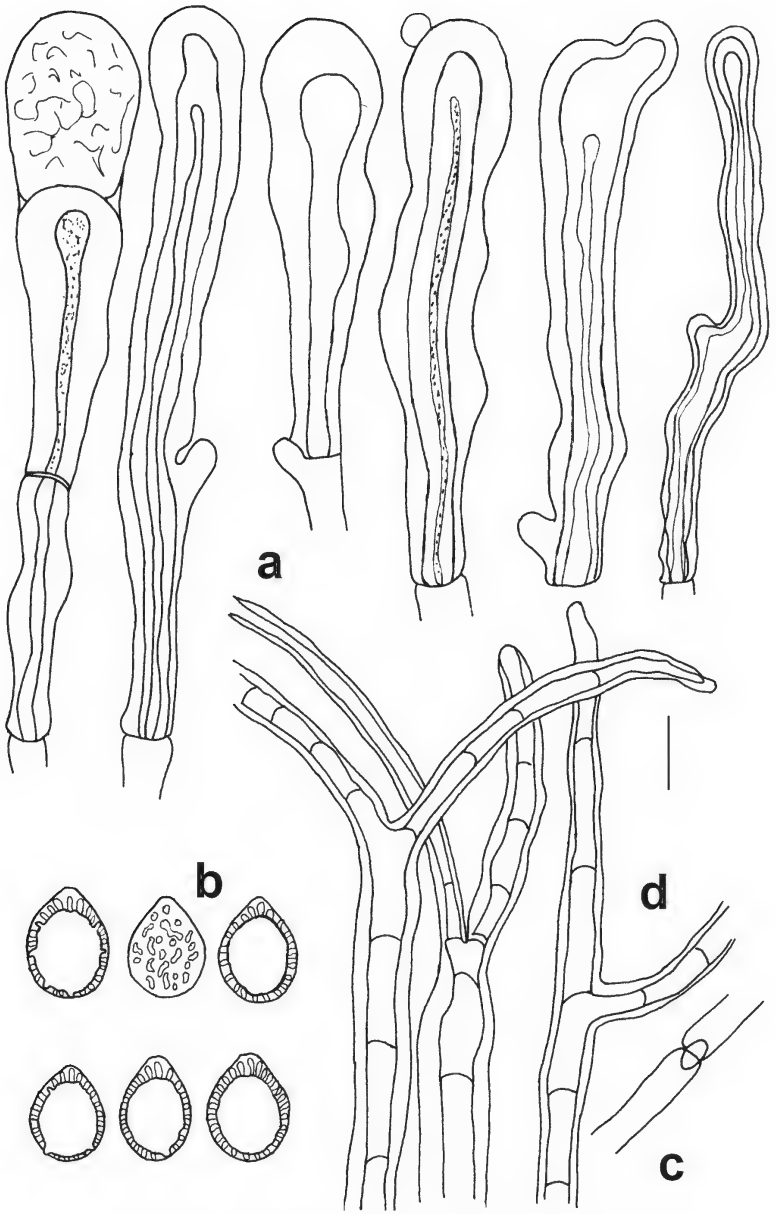

FIG. 23. *Ganoderma perturbatum* (SP60278). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores.
c–d. Hyphal system of crustohymenoderm: **c**. Generative hyphae. **d**. Skeletal hyphae.

Remarks: Distinctive features of *G. perturbatum* are the stipitate basidiome, a not fully homogeneous context, entire pileipellis cells with multi-stratified walls, and basidiospores with a subacute apex and partially anastomosed pillars. Steyaert (1967) synonymized it with *G. dorsale* and Ryvarden (1990) considered it in the *G. lucidum* complex. *Ganoderma dorsale* is similar, but differs by a duplex context and generally incrusted pileipellis cells. Although only a small fragment of the *G. lucidum* neotype remains [F. Fennici Exsiccati 239, Finland, Aboa (Turku), Runsala, n. hosp, P.A. Karsten 1858 (H, neotype)], it demonstrates a pale and homogeneous (maybe not fully homogeneous) context, and basidiospores with sub-free pillars that distinguish it from *G. perturbatum*. The specimen SP60278 was labeled as *G. lucidum* in SP. This is the second world record for *G. perturbatum*. Although known only from Brazil, this species likely has a wider tropical distribution.

Ganoderma perzonatum Murrill, N. Amer. Fl. 9: 121 (1908). Figs 10, 24

Basidiomata 3.5–10 × 3–12 × 0.6–1.8 cm, annual, substipitate, occasionally imbricate, woody-corky, light in weight. Pileus flabelliform to round-flabelliform, convex to applanate; surface glabrous, bumpy, glossy to semiglossy, concentrically sulcate; with a laccate crust, not cracking, difficult to remove, easy to penetrate with the fingernail; surface almost homogeneous violet-brown (11F8), to garnet-red (11E8) towards the margin; margin whitish to generally concolorous, entire, thin, smooth. Context 0.3–0.9 cm thick, 0.7 cm average, fibrous, not fully homogeneous, pale in general, pale-orange to light orange (5A3, 5A4) upwards, gradually changing to light brown (6D7) toward the tubes but in a narrow zone, zonate; with resinous bands. Pores 4–6 per mm, angular to round, woody; pore surface pale-yellow (2A3) to sun-yellow (2A5); tubes 0.5–0.7 cm thick, unstratified to stratified, concolorous with the lower part of the context. Hyphal system dimitic. Contextual trama: no generative hyphae were observed; skeletal hyphae 5–13 μm diam., generally solid to thick-walled, non-septate, arboriform, yellowish to golden-yellow. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 50–86 × 6.2–13.6 μm, cylindrical, apex obtuse to rarely subcapitate, entire or with one lateral protuberance; thick-walled, generally multi-stratified only in the apex, golden-yellow, with concentric elongate granulations in the apex; dextrinoid. Basidiospores 8.3–10.2 × 5.9–7.4 μm, Q = (1.25–)1.33–1.53, widely ellipsoid to ellipsoid, apex truncate, with apical germ pore, light yellowish-brown, inamyloid; perisporium wrinkled, hyaline; exosporium with inter-walled pillars up to 0.3 μm thick, free; endosporium wrinkled. Basidia 15.5–18.6 × 8–11 μm, utriform, hyaline. Cystidia absent.

Habitat: Mangrove, Amazonian forest.

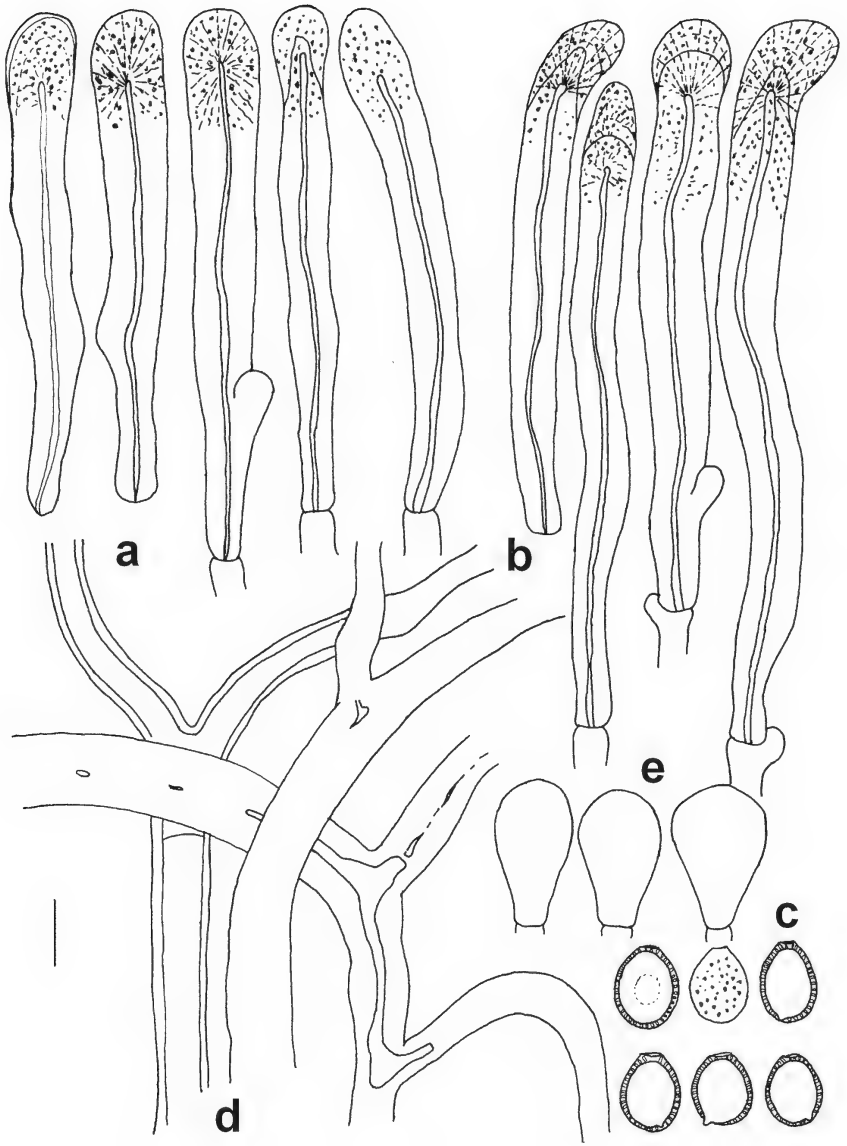

Fig. 24. *Ganoderma perzonatum* (a, c–e: SP50687, b: SP233313). Bar = 8 µm.
a–b. Pileipellis cells **c**. Basidiospores. **d**. Crustohymeniderm: skeletal hyphae. **e**. Basidiola.

Material examined: **CUBA, La Habana**, Santiago de Las Vegas, on mango log, F.S. Earle 309 (UPS, lectotype). **BRAZIL, Amapá**, Grande do Curua, Bailique, Igarapé, on dead wood, 22 September 1988, H. Sotão & coll. 88.18.13 (SP233313); mangrove, Ilha de Maracá, on dead wood, January 1989, H. Sotão & coll. 88.21.06 (SP233306); **Pará**, Santarém, 21 November 1965, B. Lowy 228B (SP92143); **Rio Grande do Sul**, Porto Alegre, Parque Farroupilha, on *Salix babylonica* trunk, 4 Jun 1960, J.C. Paim Costa s.n. (SP50687).

Remarks: *Ganoderma perzonatum* can be identified by its pale context, small basidiospores, and cylindrical pileipellis cells with apical elongate concentric granulations. The studied specimens agree with the lectotype, which, however, has inconspicuous resinous bands in the context. Ryvarden (2000) described "oblong ellipsoid" basidiospores but with the same dimensions as described here. This is the second world report for *G. perzonatum*, previously known only from Cuba. Although Mycobank (http://www.mycobank.org/) cites *G. perzonatum* as a synonym of *G. parvulum*, we regard them as independent (see Remarks under *G. parvulum*). For other related species see Torres-Torres et al. (2008). Three of the studied specimens were labeled as *G. lucidum* in SP.

Ganoderma pulverulentum Murrill, N. Amer. Fl. 9: 121 (1908). Figs 11, 25

Basidiomata 10 × 15 × 1.5 cm, annual, sessile, imbricate, woody-corky, light in weight. Pileus round-flabelliform, applanate; surface glabrous, bumpy, soft-corky, semiglossy, concentrically sulcate; with a laccate crust, not cracked, generally difficult to remove, easy to penetrate with the fingernail; surface very dark reddish-black, almost black close to the base of the pileus, to photo-brown (9F8), henna (7E8) to oxide-red (8E8) towards the margin; margin whitish, lobulate, thin, smooth. Context 0.7–0.9 cm, fibrous-corky, not fully homogenous, ochre-yellow (5B6) to dark brown (7F7) close to the tubes, zonate; with discontinuous resinous bands. Pores 4–5 per mm, angular to round, woody; pore surface cream to pale-yellowish (3A3), darkening when bruising or aging; tubes 0.7–1 cm thick, stratified, concolorous with the lower part of the context. Hyphal system trimitic. Contextual trama: generative hyphae 4–4.8 μm, thin-walled, with conspicuous clamps, hyaline; skeletal hyphae 2.8–12.8 μm diam., thick-walled to solid, non-septate, arboriform or not, very branched, yellowish to golden-yellow, predominant; binding hyphae 1.6–4 μm diam., subthick-walled to solid, non-septate, hyaline to yellowish, scarce. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 37.2–59 × 8–16 μm, narrowly clavate to clavate, generally entire; thick-walled, apex with scarce granulations, golden-yellow to yellowish-brown, amyloid. Basidiospores 9.6–12.8 × 6.2–8 μm, Q = 1.41–1.64, ellipsoid, apex truncate, with apical germ pore, yellowish-brown, inamyloid; perisporium semi-wrinkled, reddish-yellow; exosporium with inter-walled pillars 0.4–0.5 μm thick, partially anastomosed; endosporium smooth. Basidia not observed. Cystidia absent.

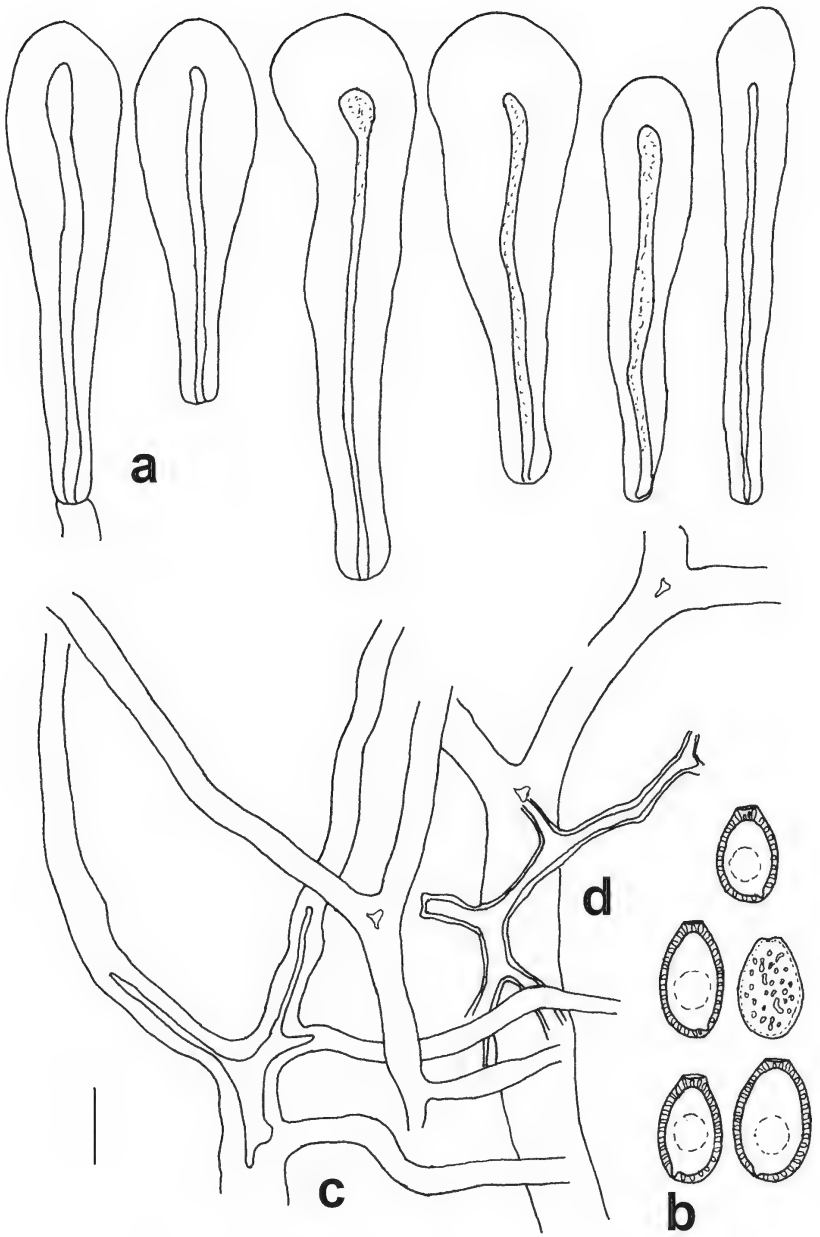

Fig. 25. *Ganoderma pulverulentum* (SP103257). Bar = 8 μm.
a. Pileipellis cells. **b**. Basidiospores.
c–d. Crustohymeniderm: **c**. Skeletal hyphae. **d**. Binding hyphae.

Habitat: Tropical secondary vegetation, near the city.

Material examined: **GRENADA**, on dry manchinell, W.E. Broadway s.n. (NY, lectotype). **BRAZIL**, **Bahia**, Correntina, on trunk, 28 January 1967, D.M. Vital s.n. (SP 103257).

Remarks: Distinctive features of *G. pulverulentum* are the lightweight basidiomata, entire pileipellis cells with granulations, and basidiospores with partially anastomosed pillars. The Brazilian specimen agrees with the lectotype, except that the latter has narrower pileipellis cells (8–11.2 μm diam.) with conspicuous granulations. This species is morphologically similar to *G. resinaceum* and *G. praelongum* Murrill, and Ryvarden (2004) synonymized it with *G. resinaceum*. However, both have a context without resinous deposits and basidiospores with free pillars. Furthermore, *G. resinaceum* has a homogenous light reddish-brown (7E7) context, while *G. praelongum* has a pale duplex context, ochre-yellow (6D7) above and rust-brown (6E8) close to the tubes (F.S. Earle & L. Murrill 536, lectotype, NY). *Ganoderma pulverulentum* was known only from the type locality, until recently recorded from French West Indies (Martinique) by Welti & Courtecuisse (2010). This is the first record of the species for Brazil. This fungus may have a wider neotropical distribution.

Ganoderma resinaceum Boud. ex Pat., Bull. Soc. mycol. Fr. 5: 72 (1889). Figs 12, 26
= *Ganoderma chaffangeonii* Pat., Bull. Soc. mycol. Fr. 5: 74 (1889).

Basidiomata 2.4–5 × 3–6.5 × 0.9–1.5 cm, annual, sessile, woody-spongy. Pileus round-flabelliform, convex to applanate; surface glabrous, uniform to slightly bumpy, slightly soft, glossy, broadly concentrically sulcate; with a laccate crust, cracked, easy to remove and to penetrate with the fingernail; surface violet-brown (darker than 11F7) to dark red in almost all the pileus, gradually changing to orange (5A7) toward the margin or fully violet-brown (11F7), darker in adult basidiomata; margin whitish, brownish-orange to concolorous, entire, thin to obtuse, smooth. Context 0.4–1.3 cm thick, fibrous-spongy, homogeneous, light reddish-brown (7E7), with an apricot (5B6) thin fringe below the laccate crust, azonate; without resinous bands. Pores 4–5 per mm, angular to circular, woody; pore surface paste yellow (2A4) to yellow (3A2) when fresh, darkening to ochraceous or yellowish-brown (6C5) when aging or drying; tubes 0.1–0.5 cm long, stratified, concolorous with the context. Hyphal system trimitic. Contextual trama: no generative hyphae were observed; skeletal hyphae 1.9–6.8 μm diam., thick-walled, generally thick-walled to solid, non-septate, arboriform or not, moderately branched, golden-brown; no binding hyphae were observed. Hymenophoral trama: generative hyphae 1.9–3.1 μm diam., thin-walled, hyaline, scarce; skeletal hyphae 2.8–7.5 μm diam., thick-walled to solid, non-septate, arboriform or not, moderately branched, golden-brown; binding hyphae 2.8–4.4 μm diam., generally thick-

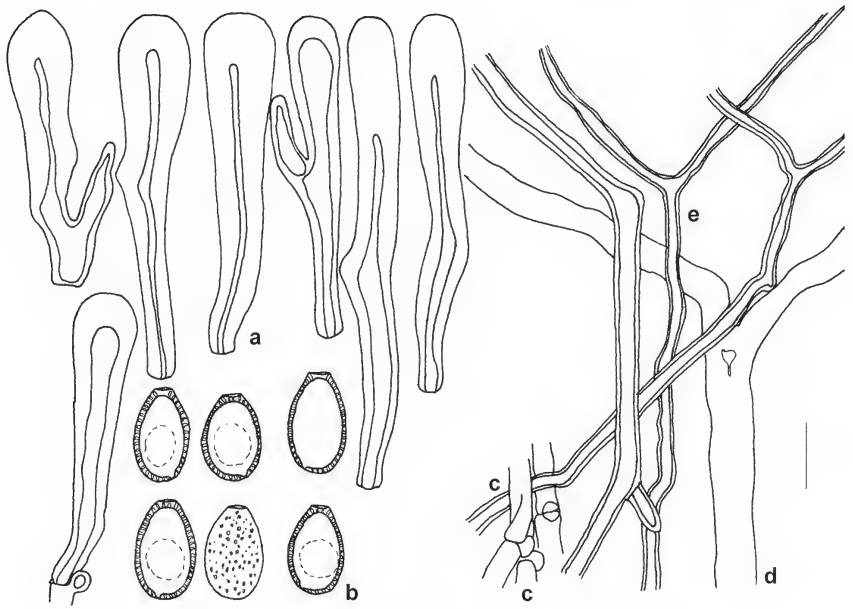

Fig. 26. *Ganoderma resinaceum* (SP61535). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores.
c–e. Crustohymeniderm: **c**. Generative hyphae. **d**. Skeletal hyphae. **e**. Binding hyphae.

walled to solid, non-septate, golden-yellow to yellowish-brown. Pileipellis a crustohymeniderm, cells 34–59 × 6.2–9.3 µm, clavate, narrowly clavate, or almost cylindrical, generally without protuberances or branches, few with one lateral branch, thick-walled to solid, apex with granulations, brownish-yellow, amyloid. Basidiospores 11.2–12.5 × 6.5–7.4 µm, Q = 1.5–1.72, ellipsoid to oblong, apex truncate, with apical germ pore, yellowish-brown, inamyloid; perisporium smooth, hyaline; exosporium with inter-walled pillars up to 0.4 µm thick, free; endosporium wrinkled, reddish-brown. Basidia not observed. Cystidia absent.

Habitat: Not specified.

Material examined: **FRANCE**, **Loir-et-Cher**, Blois, on *Quercus* trunks in mature forest, J.L. Boudier s.n. (PC, holotype). **VENEZUELA**, Orinoco region, on trunks of trees, 1885, J. Chaffangeon s.n. (PC, holotype of *G. chaffangeonii*; FH, isotype). **BRAZIL**, **Mato Grosso**, Rio Alto Juruena, August 1962, M. Mee s.n. (SP61535).

Remarks: This species presents a generally very dark pileus, homogenous brown context, smooth cylindrical pileipellis cells, and relatively large basidiospores with free pillars. Although *G. resinaceum* is a rare species, many authors have used this name for organisms with very different features. For

example, Ryvarden & de Meijer (2002) listed as *G. resinaceum* de Meijer 1418 (EMBRAPA), which properly represents *G. parvulum*, and de Meijer 2776 and 3238 (EMBRAPA), which correspond to a different, unidentified species. For this reason, based on the literature, its distribution is uncertain. Steyaert (1980) proposed synonymizing *G. chaffangeonii* with *G. resinaceum;* we examined type specimens of both taxa and agree with this opinion.

Ganoderma sessiliforme Murrill, Bull. New York Bot. Gard. 8: 149 (1912).

Figs 13, 27

Basidiomata 4–7 × 5.7–10 × 1.1–1.2 cm, annual, sessile to substipitate, occasionally imbricate, woody, but light in weight. Pileus flabelliform to semicircular, somewhat conchate to convex; surface glabrous, rugose to radially rugose, hard, semi-glossy, slightly concentrically sulcate; with a laccate crust, not cracking, easy to remove and to penetrate with the fingernail; surface darker than violet-brown (9F8) in the 80% of the pileus, wine-red (11D8) towards the margin; margin whitish to mandarin-orange (6B8), entire to slightly lobulate, acute to obtuse, smooth. Substipe 3 × 1–1.5 cm, horizontal, flattened, solid, surface shiny, red-wine to almost black, darker than the pileus. Context 0.5–0.7 cm, fibrous, homogeneous to not fully homogeneous, pale in general, orange-white (5A2), cocoa (6E6) toward the tubes, with a deep yellow (4A8) fringe below the laccate crust, azonate; without resinous bands. Pores 3–4 per mm, angular, woody; pore surface pale-yellow to pastel-yellow (3A3, 3A4), darkening to brown (6D8) when bruising or aging; tubes 0.4–0.6 cm thick, darker than context. Hyphal system dimitic. Contextual trama: no generative hyphae were observed; skeletal hyphae 2.5–11.2 µm diam., mainly solid to some thick-walled, septate to non-septate, arboriform, with few branches to branched, yellowish to golden-yellow, predominant. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 52.7–68.2 × 6.8–14.8 µm, narrowly clavate to clavate, generally smooth or with one lateral protuberance, thick-walled, golden-yellow, without granulations, slightly amyloid. Basidiospores (8.7–)9.9–10.3 × 6.3–8.8 µm, Q = 1.31–1.57, ellipsoid, apex truncate, with apical germ pore, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars 0.3–0.4 µm thick, subfree, in some free; endosporium wrinkled. Basidia not observed. Cystidia absent. Chlamydospores 11–16.7 × 7.4–13 µm, Q = 1.35–1.6(–2), ellipsoid, with one or both apexes mucronate, thick-walled, yellowish.

Habitat: Not specified.

Material examined: **MEXICO, Morelos**, Municipality of Cuernavaca, on dead wood, 24–27 December 1909, W.A. & E.L. Murrill 392 (NY, holotype). **BRAZIL, Rio Grande do Sul**, Porto Alegre, Parque Saint Hillaire, on wood, 30 April 1960, M.H. Homrich s.n. (SP61432).

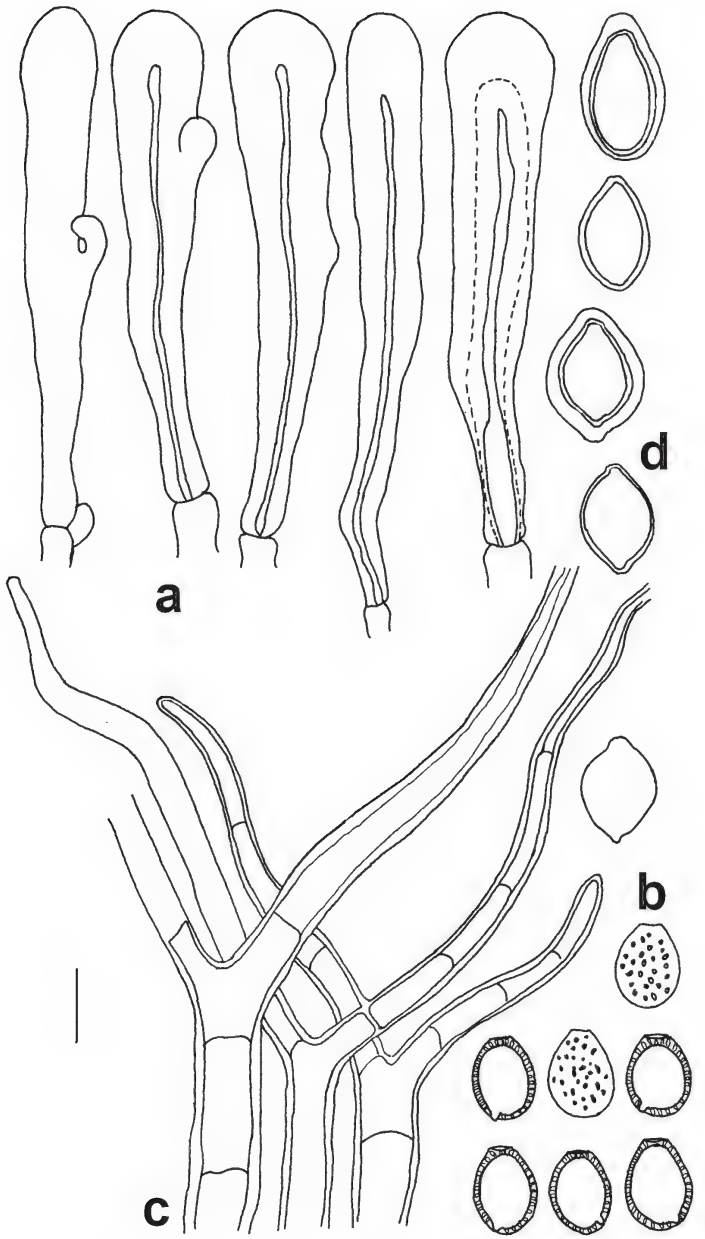

Fig. 27. *Ganoderma sessiliforme* (SP61432). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores. **c**. Crustohymeniderm: skeletal hyphae. **d**. Chlamydospores.

Remarks: This species has generally a conchate basidiome, pale context without resinous deposits, and relatively small basidiospores. Ryvarden (2004) did not include *G. sessiliforme* in his treatment of neotropical polypores. This is the second record of the species for Brazil, where it was previously recorded by Gottlieb & Wright (1999a). It is a rare fungus, known only from Argentina, Brazil, and Mexico.

Ganoderma subfornicatum Murrill, N. Amer. Fl. 9: 121 (1908). Figs 14, 28

Basidiomata 3.4–10.5 × 4–8 × 1.3–1.8 cm, perennial, substipitate, rarely with a long stipe, with a contracted base, woody. Pileus round-flabelliform, generally applanate; surface glabrous, bumpy, slightly to radially rugose, very shiny, remarkably concentrically sulcate; with a laccate crust, difficult to remove, hard but easily to penetrate with the fingernail; surface totally reddish-brown (darker than 9F8) almost black, homogenous; margin concolorous with the pileus, entire, thick, obtuse to truncate, sulcate. Substipe 1.4–2(–5.3) × 1.2–2.3 cm, generally short and thick, cylindrical, horizontal or lateral, concolorous with the pileus, solid. Context 0.4–0.8 cm thick, fibrous, not fully homogeneous, pale in general, yellowish-orange (4B7) upwards, gradually changing to rust-brown (6E8) next to the tubes; with resinous bands. Pores 4–6 per mm, round, woody, very small; pore surface brown (6D8); tubes 0.6–1 cm long, stratified, concolorous with the base of the context. Hyphal system trimitic. Contextual trama: generative hyphae 2.4–4.3 µm diam., thin-walled, with large and conspicuous clamps, hyaline to yellowish; skeletal hyphae 5.6–11.2 µm diam., generally solid, not-branched or with few branches, golden-yellow to yellowish-brown, predominant; binding hyphae 1.2–3.7 µm diam., solid, non-septate, hyaline to yellowish, scarce, notably thinner and paler than skeletal hyphae. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 37.2–62 × 5–9.3 µm, cylindrical to irregular, not clavate, commonly with a constriction near to the apex, generally with one to two branches (occasionally three) and up to five protuberances, mainly solid to thick-walled, not multi-stratified-wall, apex with ferruginous granulations, yellowish, slightly amyloid. Basidiospores 9.6–11.8 × 6.4–8 µm, Q = 1.41–1.69, ellipsoid to oblong, apex truncate, slightly visible apical germ pore, yellowish, inamyloid; perisporium semi-wrinkled, reddish-brown; exosporium with inter-walled pillars up to 0.4 µm thick, free; endosporium semi-wrinkled. Basidia not observed. Cystidia absent.

Habitat: Seasonal forest, Amazonian ombrophilous rain forest, Atlantic rain forest.

Material examined: **BELIZE**, s.loc., on dead wood, 1906, M.E. Peck s.n. (NY, lectotype). **BRAZIL**, **Paraná**, Paranaguá, Pontal do Sul, on wood, 23 October 1968, G. Hatschbach 20106 (SP8633); Antonina, Parque Marumbí, Rio do Nunes, on dead dicotyledonous trunk, 12 December 1987, A.A.R. de Meijer 962 (EMBRAPA); **Pernambuco**, Recife,

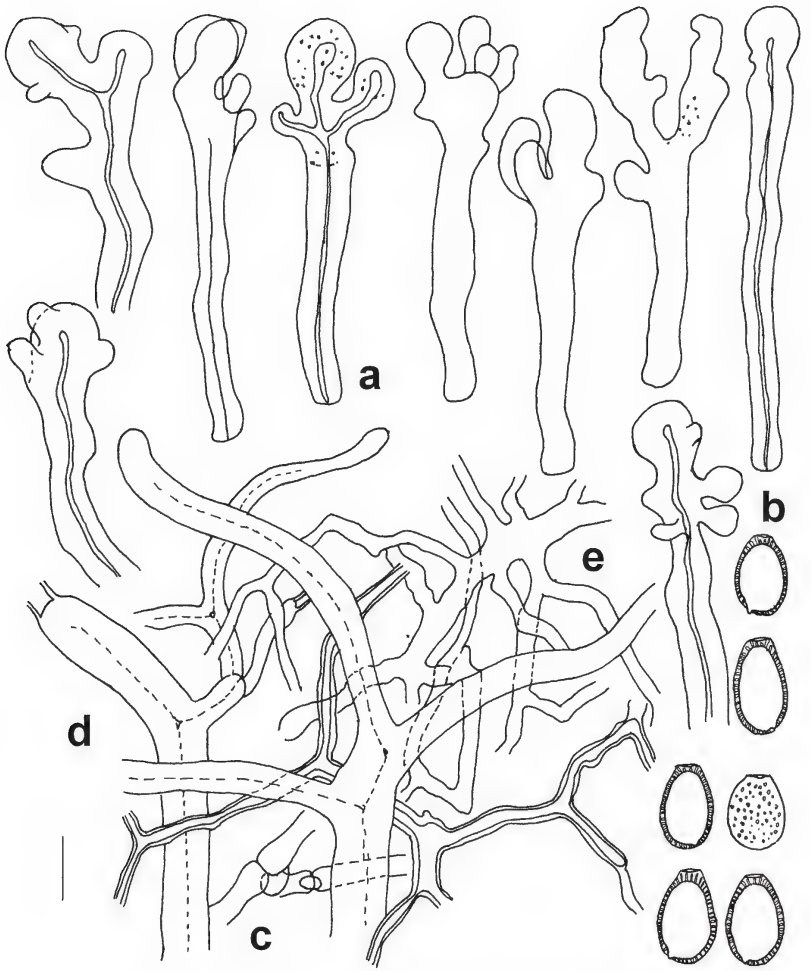

Fig. 28. *Ganoderma subfornicatum* (SP375899). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores.
c–e. Crustohymeniderm: **c**. Generative hyphae. **d**. Skeletal hyphae. **e**. Binding hyphae.

Dois Irmãos, 1 May 1956, s.coll. (SP39359); **Rondônia**, Rio Ji-Paraná, Acampamento JP-15, on wood, 8 December 1987, M. Capelari 1770 (SP214815); **São Paulo**, Cananéia, Ilha Comprida, 2 km from the beach, on wood, 25 February 1983, O. Yano & J.R. Pirani 5977 (SP214844); **Sergipe**, SE Estação Ecológica Santa Isabel, 11 November 2003, U. da Silva-Aragão s.n. (SP375899).

Remarks: This species has a shiny and dark pileus that contrasts with a generally pale context with resinous bands. Micromorphologically, it is distinguished by its pileipellis cells with many protuberances. Ryvarden (2004) did not include

G. subfornicatum in his treatment of neotropical polypores. According to Moncalvo & Ryvarden (1997), *G. subfornicatum* has been reported throughout the tropics. Rajchenberg & de Meijer (1990) cited this species from Brazil (specimens de Meijer 962 and 1234); however, later Ryvarden & de Meijer (2002) mentioned that those specimens corresponded to *G. orbiforme*. We studied them and conclude that de Meijer 1234 is *G. orbiforme* while de Meijer 962 comprises two basidiomata, one representing *G. subfornicatum* and the other (marked as de Meijer 962A) *G. applanatum* (see above).

Ganoderma vivianimercedianum M.G. Torres, Mycotaxon 105: 448 (2008).

For a complete description see Torres-Torres et al. (2008).

HABITAT: Secondary tropical forest.

MATERIAL EXAMINED: **MEXICO, ESTADO DE MÉXICO**, Valle del Tepeite, 10 km NE of Santa María, 10 August 1986, E. Bastidas-Varela s.n. (ENCB, holotype). **BRAZIL, RIO GRANDE DO SUL**, Guaiba, Fazenda da Faculdade de Agronomia e Veterinária, em lenho morto, 29 March 1963, J.P. de Costa-Neto s.n. (SP70533); **SÃO PAULO**, Tremembé da Cantareira, Villa Amalia, Horto Forestal SPSF, podridao da madeira, 20 May 1952, C.D.F. Pacheco s.n. (SP109563); **AMAPÁ**, Ilha de Maracá, tronco de madeira en descomposição, 24 October 1988, H. Sotao et al. 88.21.26 (SP233297).

REMARKS: *Ganoderma vivianimercedianum* is recognized by the flabelliform basidiomata with a contracted base, not fully homogenous light brown context, narrowly clavate to clavate pileipellis cells, entire or with up to two lateral protuberances, unbranched or rarely so, with scattered granulations in the apex, and 8.8–11.2(–12) × 6.4–8 μm basidiospores (Torres-Torres et al. 2008). This species is morphologically close to *G. argillaceum* Murrill, *G. perzonatum*, and *G. resinaceum*. *Ganoderma argillaceum* has larger basidiospores (10.4–13.6 × 7.2–9.6 μm) and pileipellis cells without granulations; *G. perzonatum* has slightly smaller basidiospores (8.4–10.4 × 6.4–7.2 μm) and remarkable large cylindrica pileipellis cells with concentric elongate granulations only in the apex; *G. resinaceum* has 11.2–13.6 × 6.5–7.4(–8.1) μm basidiospores, narrowly clavate to almost cylindrical pileipellis cells, and a fibrous-spongy homogeneous light reddish-brown context without resinous bands.

Ganoderma weberianum (Bres. & Henn. ex Sacc.) Steyaert, Persoonia 7: 79 (1972).

FIGS 15, 29

BASIDIOMATA 4–5.5 × 4–5 × 0.9–1.3 cm, annual, substipitate, with a contracted base, occasionally imbricate, woody. PILEUS semicircular, round-flabelliform to flabelliform, convex to applanate; surface glabrous, rivulose to slightly radially rugose, hard, glossy to dull; with a laccate crust, not cracking, difficult to penetrate with the fingernail, easily lost leaving the surface relatively homogeneously dull, zonate; surface reddish-black to violet-brown (11F7) or darker in almost all the pileus, except towards the margin where gradually

changes to orange (5A7) or fully violet-brown (11F7); margin pure white or yellowish, entire to slightly lobulate, thin, smooth. Substipe when present 0.9–1.5 × 1–1.5 cm, short and thick, thinner toward the base, horizontal, slightly darker than pileus, solid. Context 0.6–1 cm thick, fibrous, not fully homogeneous, light-yellow (4A4), darkening to reddish-brown (8F7) close to the tubes, changing to yellow when cut, zonate; with resinous incrustations throughout the context. Pores 4–5 per mm, angular to round, woody; pore surface yellowish-white (3A2) to sun-yellow (2A5) when fresh, darkening to ochraceous or yellowish-brown (6E8) when aging and drying; tubes 0.2–0.4 cm long, unstratified, concolorous with lower part of the context. Hyphal system dimitic. Contextual trama: generative hyphae 1.9–3.7 µm diam., thin-walled, with conspicuous clamps, non-branched, hyaline to yellowish; skeletal hyphae 1.6–8 µm diam., thick-walled to generally solid, septate to non septate, non-branched to arboriform with few branches, moderately branched, apex rounded and slightly wider near to the pileipellis, golden-yellow. Hymenophoral trama as the contextual trama. Pileipellis a crustohymeniderm, cells 46.6–65.7 × 6.2–10.6 µm, cylindrical to narrowly clavate, entire, thick-walled to solid, apex with granulations, golden-yellow, slightly amyloid (light bluish). Basidiospores 8.4–9.3 × 6.8–7.2 µm, Q = 1.29–1.5, ellipsoid, few broadly ellipsoid, apex truncate, with apical germ pore, yellowish-brown, inamyloid; perisporium wrinkled, reddish-brown; exosporium with inter-walled pillars up to 0.5 µm thick, subfree; endosporium wrinkled. Basidia 13.6–17.3 × 8–9.3 µm, widely clavate, hyaline. Cystidia absent. Chlamydospores 9.3–10.5 µm, globose, thick-walled, with inter-walled, very thick pillars, yellow.

Habitat: "Cerrado".

Material examined: **BRAZIL**, **São Paulo**, S. Paulo Brotas, km 216–217 of São Paulo-Brotas Road, Região de Cerrado, 11 January 1962, A. Milanez & D. Altimari s.n. (SP61099).

Remarks: The most important features of *G. weberianum* are a hard pileus crust, pale context that changes to yellow when cut with resinous incrustations, cylindrical pileipellis cells with granulations, and small basidiospores. The single Brazilian specimen studied agrees with the specimen recorded from China by Wang et al. (2005), except that they describe clavate pileipellis cells which nonetheless appear cylindrical in their illustration. The examined specimen matches Steyaert (1972) and Corner's (1983) descriptions except for their observations of the inter-pillars in the basidiospores as barely visible ("minutely echinulate to apparently smooth;" Corner 1983). Our examination of the basidiospore ornamentation with a higher magnification lens (1600×) enabled us to detect how the pillars ("echinula" sensu Corner and Steyaert) relate to one another, appearing in this case as free pillars mixed with some fused ones. Steyaert (1972) described two forms of *G. weberianum*: one with long narrow

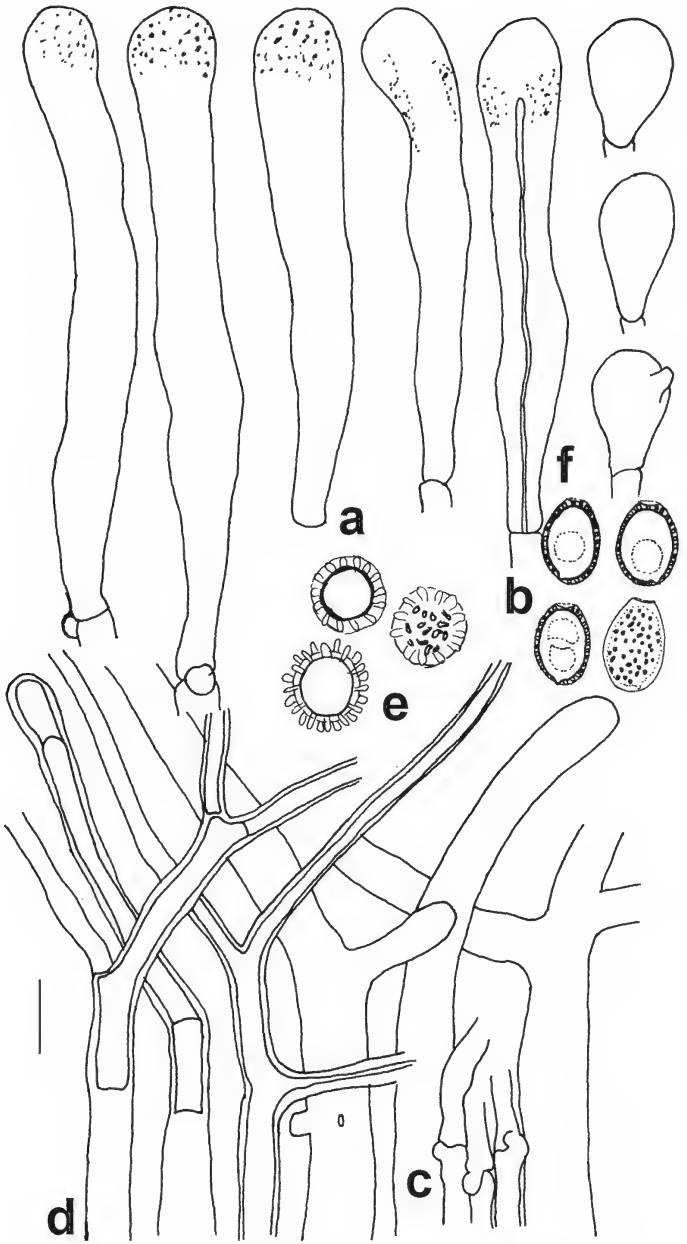

Fig. 29. *Ganoderma weberianum* (SP61099). Bar = 8 µm.
a. Pileipellis cells. **b**. Basidiospores. **c–d**. Crustohymeniderm:
c. Generative hyphae. **d**. Skeletal hyphae. **e**. Chlamydospores. f. Basidium and basidiola.

pileipellis cells (30 × 7–8 μm) and without or with few chlamydospores, and the other with short broad pileipellis cells (20 × 10–12 μm) and with abundant chlamydospores. Nevertheless, Steyaert's pictures show pileipellis cells that are longer than he described. On the other hand, Corner (1983) described long narrow pileipellis cells and abundant chlamydospores.

Ganoderma weberianum has been reported from Africa, Asia and Samoa Island (Steyaert 1972), Australia (Smith & Sivasithamparam 2000), China (Wang et al. 2005), and Singapore (Corner 1983), but Núñez & Ryvarden (2000) did not include it in their treatment of East Asian *Ganodermataceae*. This is the first record of *G. weberianum* in America.

Discussion

Although *G. annulare* (Lloyd) Boedijn, *G. bibadiostriatum* Steyaert, *G. citriporum* Ryvarden & Iturr., *G. chalceum* (Cooke) Steyaert, *G. colossus* (Fr.) C.F. Baker, *G. curtisii* (Berk.) Murrill, *G. lobatoideum* Steyaert, *G. lobatum* (Schwein.) G.F. Atk., *G. lucidum* (Curtis) P. Karst., *G. multicornum* Ryvarden, *G. multiplicatum* var. *vitalii* Steyaert, *G. nitens* (Fr.) Pat., *G. nitidum* Murrill, *G. oerstedii* (Fr.) Murrill, *G. pygmoideum* Steyaert, "*G. reniformis*" [*Elfvingia reniformis* (Morgan) Murrill], *G. subamboinense* (Henn.) Bazzalo & J.E. Wright ex Moncalvo & Ryvarden, *G. testaceum* (Lév.) Pat., *G. tropicum* (Jungh.) Bres., and *G. zonatum* Murrill have been cited from Brazil in the literature (e.g., Drechsler-Santos et al. 2008; Gerber & Loguercio-Leite 1997; Gomes-Silva et al. 2011; Gottlieb & Wright 1999a; Loguercio-Leite et al. 2005; Patouillard 1889; Steyaert 1962, 1980; Westphalen et al. 2010), they are not included in either key or descriptions because we were unable to examine any material representing them.

As a specimen of *G. sessile* Murrill was found in SP, the species is included in the key but not described; it lacked data and thus we are uncertain whether it was collected in Brazil. Gottlieb & Wright (1999a) tentatively determined BAFC 34352 from Brazil as *G. sessile*.

We exclude *G. neurosporum* J.S. Furtado [≡ *Haddowia neurospora* (J.S. Furtado) Teixeira] because basidiospores of the type specimen [Panama, Buenos Aires, on decaying root, 8 August 1945, S.L. Mayer s.n. (BPI, lectotype)] have crested ornamentations and do not correspond with *Ganoderma*.

Likewise, the type specimen of *G. opacum* (Berk. & Mont.) Pat. [Brazil, Bahía, B & M 32 (K, lectotype)] has *Humphreya*-like basidiospores. According to phylogenetic analysis with morphological and molecular data, the monophyletic *Humphreya* differs from *Ganoderma* (Torres-Torres et al. unpublished). Of the 30 specimens kept at EMBRAPA and SP labeled as *G. lucidum*, none of them belong to this species. Furthermore, it is probable that many Brazilian records under *G. lucidum* in the literature represent a minimum of nine different species, but this should be carefully verified.

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New records of pyrenocarpous lichenized fungi from Bulgaria

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Abstract — Five pyrenocarpous species of lichenized fungi, *Acrocordia salweyi, Staurothele hymenogonia, Verrucaria praetermissa, V. viridula* and *Wahlenbergiella striatula,* are reported for the first time from Bulgaria. Detailed descriptions, illustrations, and comments are provided.

Key words — *Pyrenulales,* lichen taxonomy, *Verrucariales*

Introduction

Pyrenocarpous lichens comprise lichenized fungi with perithecioid ascomata. The taxa discussed here belong to the orders *Pyrenulales* and *Verrucariales*, characterized by having usually crustose, immersed or superficial thallus, variously colored and inhabit rocks, soil and bark.

Several lichenologists have taxonomically studied *Acrocordia* species in Bulgaria (e.g. Kazandzhiev 1906; Szatala 1929; Zhelezova 1963; Pišút 1969, 2001), while many specialists (see Mayrhofer et al. 2005) have surveyed *Verrucaria* and *Staurothele,* with more recent records provided by Vondrák (2006) and Krzewicka et al. (2007). Recently five additional species were found for the first time in Bulgaria.

Material & methods

This study is based on specimens collected by the authors during 2006, 2007, and 2011 and now housed in the Mycological Collection at the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia (SOMF). Determination of species follows Smith et al. (2009). Measurements of ascospores, conidia, and hymenial algal cells are given as follows: (min–) mean ± standard deviation (–max). Macrophotographs were made by means of a Windaus Labortechnik D-38678 dissecting microscope with Canon PowerShot A630 digital camera.

Taxonomic descriptions

Acrocordia salweyi (Leight. ex Nyl.) A.L. Sm., Monogr. Brit. Lich. 2: 315, 1911. Pl. 1A

Thallus immersed or superficial, greenish-grey to pale brown, thin. Perithecia 620–800 µm diam., one-quarter to half immersed. Involucrellum tightly incurved around the exciple and continuous below. Ascospores (19.7–) 22.4 ± 1.3(–25.8) × (8.3–)10.0 ± 0.7(–11.3) µm, l/w ratio usually c. 2.2 (n = 25), colorless, ellipsoid, 1-septate. Pycnidia 0.2–0.3 mm diam. Conidia (3.0–)3.5 ± 0.4(–4.6) × (1.2–)1.5 ± 0.1(–2.0) µm, l/w ratio usually >2.2 (n = 25).

Specimen examined — **Bulgaria,** Shoumen Plateau, Bukaka Nature Reserve, on sedimentary rocks in a shady habitat, 25 October 2007, D.Y. Stoykov (SOMF 27 992).

Ecology & distribution — In shaded habitats on soft calcareous rocks. *Acrocordia salweyi* occurs in the sub-Atlantic region of the temperate zone over the sub-Mediterranean region to the Mediterranean area (Wirth 1995). Known from Europe (Santesson et al. 2004, Liška et al. 2008, Smith et al. 2009).

Comments — Similar to *A. conoidea* (Fr.) Körb., but differing in the outwardly spreading base of the involucrellum and smaller ascospores (12–19 × 6–9 µm). Another species, *A. macrospora* A. Massal., has a laterally spreading involucrellum, but it never continues below the exciple.

Staurothele hymenogonia (Nyl.) Th. Fr., Bot. Not. 1865: 40, 1865. Pl. 1B

Thallus endolithic, grey. Perithecia 270–420 µm diam., superficial, leaving small shallow pits in the rock, dusted with rock fragments. Ostiole plane or in a small depression. Involucrellum present. Hymenial algal cells (3.0–)4.5 ± 0.9(–6.6) × (2.3–)2.8 ± 0.5(–3.6) µm, l/w ratio usually >1.6 (n = 50). Asci 8-spored. Ascospores (19.1–)22.4 ± 1.6(–24.5) × (10.5–)12.1 ± 0.9(–13.8) µm, l/w ratio usually >1.8 (n = 25), colorless, ellipsoid, muriform.

Specimens examined — **Bulgaria,** Forebalkan, Vratsa distr., near Stoyanovo village, on limestone rocks, 8 June 2006, D.Y. Stoykov (SOMF 27 986); Liutajik village, on calcareous rock, 7 July 2006, D.Y. Stoykov (SOMF 28 005); Stara Planina Mts (western), Lakatnik, along the path to the Temnata Doupka Cave, on pebbles, 6 September 2006, D.Y. Stoykov (SOMF 27 980); Strandzha Mts, Kovach locality near Zvezdets village, on rocks, 24 May 2007, D.Y. Stoykov (SOMF 27 995).

Ecology & distribution — On limestone as well as porous granular substrata (calcareous sandstone, sandy dolomite, chalk pebbles) in lightly shaded to well-lit habitats. From the boreal pine belt southwards to the Mediterranean area (Wirth 1995). Reported from Asia and Europe (Grillo & Caniglia 2004, Santesson et al. 2004, Seaward et al. 2004, Spribille et al. 2006, Liška et al. 2008, Smith at al. 2009).

Comments — *Staurothele hymenogonia* differs from other members of this genus by its smaller colorless spores.

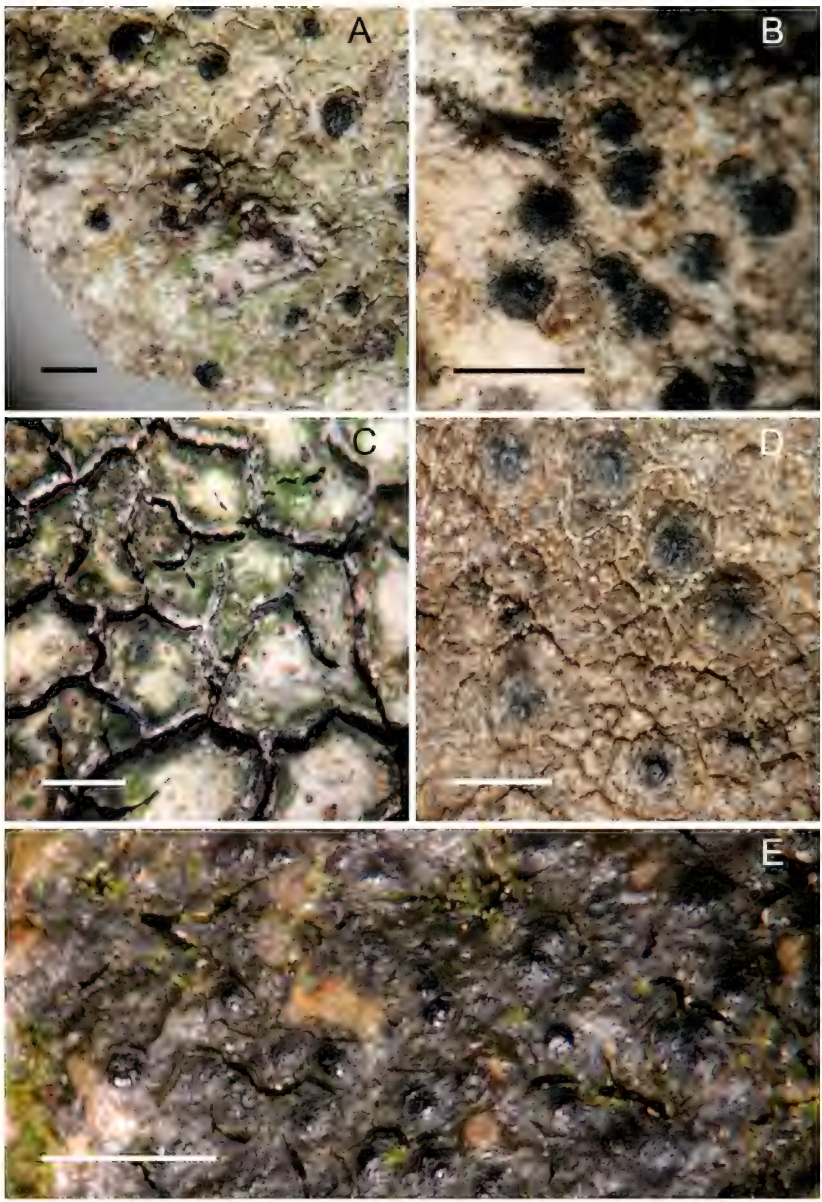

Plate 1. A. *Acrocordia salweyi* (SOMF 27 992). B. *Staurothele hymenogonia* (SOMF 27 986). C. *Verrucaria praetermissa* (SOMF 27 977). D. *Verrucaria viridula* (SOMF 27 991). E. *Wahlenbergiella striatula* (SOMF 28 001). Scale bars = 1 mm.

Verrucaria praetermissa (Trevis.) Anzi, Comment. Soc. Crittog. Ital. 2(1): 24, 1864. Pl. 1C

Thallus 40–260 µm thick, superficial, non-gelatinous, pale green or grey-brown; surface smooth, with numerous cracks when well developed. Prothallus white. Perithecia immersed in thallus, at most forming very low projections, which are too ill-defined to measure; apex visible as a pink or brown dot. Involucrellum conical, extending laterally and fusing with dark basal layer below. Asci 60–85 × 13–25 µm, 8-spored, clavate. Ascospores (15.5–)18.8 ± 1.8(–21.3) × (6.2–)8.0 ± 0.9(–10.0) µm, l/w ratio usually >2 (n = 25), colorless, ellipsoid, simple. Conidia (4.0–)5.0 ± 0.6(–6.2) × (0.9–)1.2 ± 0.1(–1.5) µm, l/w ratio usually >4 (n = 50), rod-shaped, some slightly curved.

Specimen examined — **Bulgaria,** Shoumen Plateau, near the entrance of the Zandana Cave, on frequently inundated sedimentary rock in a shady habitat, 23 October 2007, D.Y. Stoykov (SOMF 27 977).

Ecology & distribution — Amphibious in the splash water zone, rarely submerged for long periods. On hard and stable slightly acidic to basic siliceous or calcareous substrata near freshwater sources. Tolerating a wide range of illumination. From sea level to high mountain areas, very rarely reaching alpine sites (Thüs & Schultz 2009). Known from North and Central America, Asia, Australia, Europe, New Zealand (Aptroot & Seaward 1999, Smith et al. 2009).

Comments — Similar to *Verrucaria hydrela* Ach., which usually develops thin subgelatinous crust with the basal involucrellum and exciple generally separated. There is no free space between the involucrellum and the exciple in *V. praetermissa*. Another close species, *V. elaeina* Borrer, has a thin epilithic thallus and prominent perithecia but lacks a black basal layer.

Verrucaria viridula (Schrad.) Ach., Method. Lich., Suppl.: 16, 1803. Pl. 1D

Thallus immersed or superficial, pale brown to whitish, areolate, divided by cracks. Perithecia 200–500 µm diam., half to almost completely immersed in thallus, appearing as convex to conical-hemispherical projections, with basal part immersed in the substratum. Involucrellum poorly developed, seen only in the upper half of the exciple. Ascospores (27.9–)32.6 ± 2.9(–38.5) × (15.3–)19.1 ± 1.5(–22.1) µm, l/w ratio usually >1.7 (n = 25), ellipsoid to broadly ellipsoid, sometimes with perispore. Pycnidia appearing as dark dots. Conidia (8.5–)10.0 ± 1.2(–13.2) × (0.9–)1.3 ± 0.2(–1.8) µm, l/w ratio usually >7.5 (n = 25), straight to slightly curved.

Specimen examined — **Bulgaria,** Mt Vitosha, above Douhlata Cave, on calcareous rock, 22 May 2011, V.V. Shivarov (SOMF 27 991).

Ecology & distribution — In foothill and submontane sites. On calcareous rocks (including limestone). Widely distributed in Europe (from temperate regions to the Mediterranean area), it is also known from Africa, North and

Central America, Asia, Australia, and Macaronesia (Wirth 1995, Santesson et al. 2004, Spribille et al. 2006, Liška et al. 2008, Smith et al. 2009).

Comments — *Verrucaria viridula* is variable but distinguished by its large ascospores and the apex of the perithecium, which often forms a beak. The thallus is typically superficial, cracked, and occasionally scarcely apparent. *Verrucaria hochstetteri* Fr. has similar-sized spores but differs by its endolithic thallus and absence of involucrellum.

Wahlenbergiella striatula (Wahlenb.) Gueidan & Thüs, Taxon 58: 199, 2009. Pl. 1E

Thallus superficial, subgelatinous, green to dark dull green, translucent when wet, very thin or up to 250 µm, cortex absent. Perithecia 180–350 µm diam., forming prominent conical projections, with often irregular shape, usually divided by large irregular ostiole. Exciple dark brown, but paler at base. Involucrellum thick, appressed to exciple and broadened at base. Hymenial gel I+ blue, then light purple. Ascospores (6.2–)8.7 ± 1.1(–11.0) × (4.2–)6.0 ± 0.8(–7.1) µm, l/w ratio usually c. 1.4 (n = 25), ellipsoid. Pycnidia not seen.

Specimen examined — **Bulgaria,** Black Sea coast, Sinemorec village, near the North Beach, on rocks periodically flooded by water, 13 September 2011, V.V. Shivarov (SOMF 28 001).

Ecology & distribution — Maritime species in mid-littoral zone on rocky seashores. Reported from America (North), Australia, Europe, and New Zealand (Santesson et al. 2004, Orange 2008).

Comments — *Wahlenbergiella* has recently been separated from *Verrucaria* to accommodate the two marine species, *V. mucosa* Wahlenb. and *V. striatula* Wahlenb. (Gueidan et al. 2009). *Verrucaria halizoa* Leight., the only close species recorded from the Bulgarian Black Sea coast (Krzewicka et al. 2007), differs in its thin olive-green thallus, different perithecial shape, and oblong-ellipsoid ascospores with l/w ratio up to 3.5.

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We are grateful to Dr Volker John (Pfalzmuseum für Naturkunde, Germany) and Dr László Lőkös (Department of Botany, Hungarian Natural History Museum, Hungary) for critically reading the manuscript and serving as pre-submission reviewers, and to Prof. Mark R.D. Seaward (University of Bradford, Bradford, UK) for checking a part of the manuscript and for useful suggestions. We would like to thank Dr Beata Krzewicka (W. Szafer Institute of Botany, Krakow, Poland) for her help with identification of *Verrucaria praetermissa.*

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Lichenological notes 5: Neotypification of *Sarcogyne magnussonii* (*Acarosporaceae*)

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Abstract — *Sarcogyne magnussonii* is neotypified and its description revised based on new specimens from Canada.

Key words — biodiversity, calciphiles, North America, typification

Introduction

The holotypes for four species of *Sarcogyne* described from single specimens from North America (Magnusson 1935) were missing when the first author began studying the genus as part of the Sonoran lichen flora project in 2004. Three of these were in the herbarium of Maurice Bouly de Lesdain and were presumed destroyed in the bombing of Dunkirk in France during WW2: *Sarcogyne novomexicana* H. Magn., *Sarcogyne integra* B. de Lesd. ex H. Magn., and *Sarcogyne magnussonii*. The holotype of the fourth species, *Sarcogyne athroocarpa* H. Magn., was in the Farlow Herbarium (FH), but the *Sarcogyne* is missing from the rock of the type on which there only remains a *Lecidea* taxon that was misidentified as *Sarcogyne "privigna"* auct. non (Ach.) A. Massal. and unambiguously fails to match the protologue (Magnusson 1935). No *Sarcogyne athroocarpa* was found on a duplicate of this collection in NY, only another specimen of the misidentified *Lecidea* species.

Knudsen & Lendemer (2005) designated a neotype for *Sarcogyne novomexicana* that was deposited in the Uppsala Herbarium (UPS) with a duplicate deposited in the New York Botanical Garden (NY). *Sarcogyne novomexicana* has proved to be a rare calcicolous species known currently only from California from Joshua Tree National Park in Riverside County, the San Bernardino Mountains in San Bernardino County, and Yosemite National Park

in Mariposa County (Knudsen & Kocourková, unpublished data; Knudsen & Standley 2007).

The types of *S. integra* and *S. magnussonii* were from the mountains of New Mexico and *S. athroocarpa* was from the mountains of Colorado. Despite our attention to these taxa, we found no material from western North America that could be attributed to these three species. We hypothesized they belonged to a distinctive North American biogeographic unit of lichen distribution we have noted during our taxonomic studies. It encompasses northeastern North America from the Rockies to the Atlantic with the ranges of some species extending south into non-Sonoran Mexico and west into Sonoran Arizona. For instance, *Acarospora chrysops* (Tuck.) H. Magn., *A. janae* K. Knudsen, and *A. tuckerae* K. Knudsen share this distributional pattern (Knudsen 2007; Knudsen et al. 2011; Lendemer 2010). In 2009 and 2010, the lichenologist Colin Freebury (CANL) sent us specimens of a *Sarcogyne* from the northern border of this biogeographical unit on a calcareous conglomerate boulder in Grasslands National Park, in Saskatchewan, Canada (Plate 1). We were surprised when these specimens matched the description of *Sarcogyne magnussonii* (Magnusson 1935). We revise Magnusson's description and designate a neotype to be deposited at CANL and isoneotype at UCR.

Materials & methods

Specimens were examined from CANL, COLO, FH, NY, and UCR. Specimens have been examined using standard microscopical techniques. Structures were studied in water and 10% KOH [K]. Amyloid reactions were tested in Lugol's iodine [I] with and without pretreatment with K. Ascospore measurements were made in water with an accuracy of 0.5 µm. Macrophotographs were taken with a digital camera Olympus DP72 mounted with Quick Photo Camera 2.3 on an Olympus SZX 7 Stereomicroscope. The illustrations were prepared using Adobe Photoshop. The pictures of neotype locality were taken by Colin Freebury.

The species

Sarcogyne magnussonii B. de Lesd., Ann. Crypt. Exot. 5: 107 (1932). Plates 1, 2

Type: **U.S.A. New Mexico.** environs of Las Vegas, Brouard s.n. (Hb. B. de. Lesd, n.v., presumed destroyed). **CANADA. Saskatchewan.** Grasslands National Park, sloped grassland with scattered boulders, 49°10.903′N 107°41.346′W, 795 m, common on a conglomerate boulder of glacial erratic, composed of mostly rounded quartz pebbles held together by calcite May 2, 2010. C. Freebury 1260 (CANL, **neotype designated here;** UCR, isoneotype).

Description — Thallus epilithic, white, about 0.3 mm thick, covering several cm, cracked not areolate, farinose, coating the substrate, unstratified, ecorticate of gelatinized hyphae or polysaccharide secretions mixed with abundant large crystals not dissolving in K, with some distinct hyphae 4–5 µm

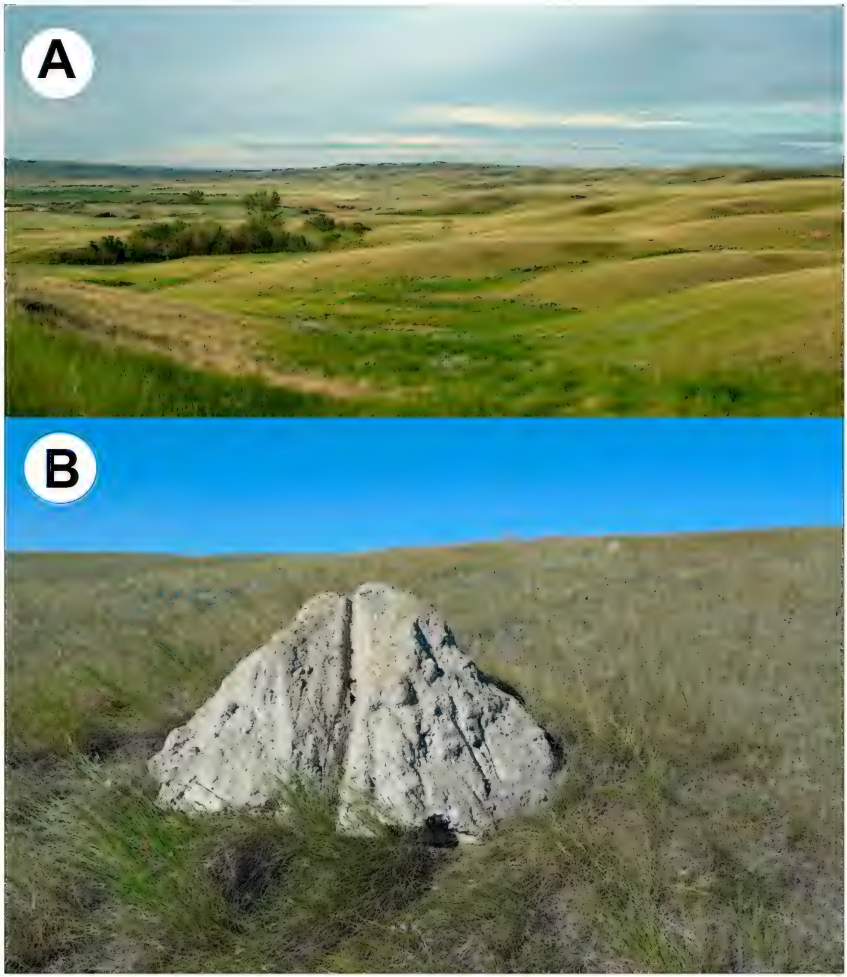

PLATE 1. *Sarcogyne magnussonii.* A, Locality of *S. magnussonii* in the Grasslands National Park in Saskatchewan, Canada. B, Solitary boulder with *S. magnussonii*.

wide, and with scattered algal cells, sometimes forming a thin continuous to broken layer (some non-fertile parts of the thallus are necrotic lacking distinct hyphae or lichenized algae or pycnidia, formed only of gelatinized hyphae or polysaccharide secretions and crystals). Apothecia dispersed, emergent, 0.3–1.5 mm in diam., broadly attached with thin algal layer beneath the hypothecium; disc usually smooth, reddish-black and epruinose, becoming only slightly redder when wetted, with thin, smooth, black margins, slightly elevated above the disc, not becoming convex, stipitate, or immarginate and

PLATE 2. *Sarcogyne magnussonii* (C. Freebury 1260, isoneotype, UCR), thallus with apothecia. Scale bar = 1 mm.

with no signs of vegetative division. Exciple 100–150 µm thick, of radiating hyphae, outer layer blackish, internally reddish-brown to hyaline, apices expanded up to 6 µm. Hymenium 80–100(–120) µm tall, I+ blue turning yellow-green or red, K/I+ blue, epihymenium 10–15 µm tall, yellowish-brown, paraphyses mostly 2 µm thick, septate, rarely constricted at septa, cells up to 10 µm long, the upper three or four becoming shorter, 3–5 µm long, apices firmly conglutinate, expanded to 3.0–3.5 µm or barely expanded, clavate or not. Asci clavate, 60–70 × 18–20 µm, 100–200 ascospores per ascus. Ascospores various, 4–6 × 2–3 µm, mostly 2 µm wide, often with 1 or 2 oil drops. Subhymenium poorly differentiated from hymenium 30–50 µm thick, I+ blue. Hypothecium narrow, prosoplectenchymatous, c. 10–15 µm thick, poorly differentiated, merging into the exciple. Algal layer beneath the apothecium, usually thin, 20–30 µm thick, algal cells mostly 10 µm diam. Medulla prosoplectenchymatous and gelatinized, continuous with attaching hyphae and thallus, obscure with crystals not dissolving K, and with scattered algal cells, up to 200 µm high. Pycnidia visible as black dots, globose, 50–100 µm in diam. Conidia hyaline, simple, either globose (1 × 1 µm) or minutely bacilliform (1.0 × 1.5 µm). Spot tests negative, containing no apparent exolites.

Other specimen examined — **CANADA. Saskatchewan:** Grasslands National Park, sloped grassland with scattered boulders, 49° 10.903′ N 107°41.346′ W, 795 m, common on a calcareous conglomerate boulder, June 18, 2009, C. Freebury 829B w/ M. Freebury (CANL).

Discussion

Sarcogyne magnussonii is abundant on a single calcareous conglomerate boulder of glacial erratic in the grasslands of Saskatchewan. The specimens from Canada match well both the scant protologue (Bouly de Lesdain 1932) and the more detailed description of Magnusson (1935).

Ecologically, like *Sarcogyne novomexicana, S. magnussonii* was originally collected on silicate rock but probably is predominately a calciphile. Like *S. "privigna," S. magnussonii* probably occurs on silicate rock in drainages or seeps where calcium is deposited during evaporation (Knudsen & Kocourková 2011).

Magnusson (1935) compared *Sarcogyne magnussonii* only with *S. similis* H. Magn. He noted that the difference between *S. magnussonii* and the widespread *S. similis* was broader ascospores (5–6.5 × 2.5–3 vs. 4–6 × 1.5 µm). We feel this is a poor character as the ascospore sizes of both species actually overlap and are variable (4–6 × 2–3 vs. 4–6 × 1.5–2.5 µm). The apothecia resemble some apothecia of *S. similis,* but do not become convex, stipitate, or immarginate and show no signs of vegetative division, all secondary characteristics of *S. similis.* The real difference between the two species is the well-developed farinose epilithic thallus of *S. magnussonii* with frequent pycnidia and emergent apothecia.

The only other North America species that sometimes produces a white or dun-colored epilithic thallus is *Sarcogyne arenosa* (Herre) K. Knudsen & Standl. (Knudsen & Standley 2007; Lendemer et al. 2009). That species usually has a chasmolithic thallus that is ecorticate and whitish when visible, often as a ring subtending the exciple. It rarely becomes epilithic, sub-corticate, and sub-areolate on crumbling rock, and can even turn a light brown in full sun. It has a firm texture, while the thallus of *S. magnussonii* is farinose. The thallus of *S. arenosa* is also thin, usually ≤ 0.1 mm thick, while the thallus of *S. magnussonii* is thicker, usually 0.3 mm. *Sarcogyne arenosa* also has mostly narrowly ellipsoid ascospores (3.5–5 × 1–1.5 µm), while the ascospores of *S. magnussonii* are usually wider (2–3 µm). *Sarcogyne arenosa* occurs on both silicate rock and soil as well as calcareous rock and soil, while *S. magnussonii* probably prefers calcareous rock and silicate rock drainages with calcium deposits. The two species may be sympatric in the Midwest or in New Mexico or Texas, but *S. arenosa* is only apparently common in California, from where it was originally described. The two species can be easily separated based on the differences in ascospore sizes and texture and thickness of the thallus.

Six *Sarcogyne* species from Europe and Asia have thinner white ecorticate epilithic or chasmolithic thalli than *S. magnussonii* and occur on calcareous rocks (Knudsen et al. 2009). They all differ especially in having larger or globose ascospores (see the "nivea group" table in Knudsen et al. 2009).

Sarcogyne cretacea Poelt grows on limestone in the Alps in Europe and produces a thicker epilithic thallus than *S. magnussonii,* 5.0 vs. 0.3 mm thick (Knudsen et al. 2009; Poelt 1964). The *S. cretacea* thallus is chalky and firm with distinct rounded contours, confluent individuals, and a dun-colored edge. The *S. magnussonii* thallus is loosely organized without any stratification and without a distinct edge. It is soft and easily abraded. The farinose ecorticate structure of *S. magnussonii* thallus would not support a thallus 5 mm thick as in *S. cretacea*. Otherwise their apothecial size, hymenium height, and ascospore size overlap and do not significantly differ. But *S. cretacea* has longer conidia than *S. magnussonii* (2.0–2.5 × 1.0 vs. 1.0 × 1.0–1.5 µm). The two species can be distinguished by the difference in the thallus structure and thickness and conidial size. Other *Sarcogyne* species are mainly identified by their thallus structure and conidia, for instance *S. crustacea* K. Knudsen & Kocourk. from California and *S. brunnea* K. Knudsen & Flakus from South America (Knudsen & Kocourková 2010; Knudsen et al. 2012).

The neotypification of *Sarcogyne magnussonii* is important for the further study of the North American lichen biota. Its revision will hopefully lead to the discovery of new populations. We are happy to designate the neotype of *S. magnussonii* and now have some hope of discovering populations of *S. integra* and *S. athroocarpa.*

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New species of *Humicola* and *Endophragmiella* from China

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Abstract —Three new species, *Humicola jilongensis, Humicola shannanensis* and *Endophragmiella zhangmuensis,* are described and illustrated from soil in China. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University, Plant Pathology (HSAUP). Isotypes are kept in the Herbarium of Institute of Microbiology, Academia Sinica (HMAS).

Key words — dematiaceous hyphomycetes, soil fungi, taxonomy

Introduction

During the course of a survey of soil dematiaceous hyphomycetes in China, several unusual species of *Humicola* and *Endophragmiella* were collected. Two *Humicola* and one *Endophragmiella* species are described and illustrated as new. The genus *Humicola* was established by Traaen (1914) and is characterized by possession of micronematous or semi-macronematous conidiophores, which are cylindric or slightly inflated. The conidiogenous cells swell apically to form globose to ovoid aleuriospores. Of the 66 taxa listed by Index Fungorum (2012), many are infraspecific, and Seifert et al. (2011) estimate that the genus may contain only 20 valid species. *Endophragmiella* was erected by Sutton (1973) with *E. pallescens* as the type species. The genus, which was emended by Hughes (1979), is characterized by solitary, acrogenous, septate conidia seceding rhexolytically from monoblastic, integrated, terminal, determinate or percurrently proliferating conidiogenous cells. More than 80 species are recorded in this genus (Index Fungorum 2012).

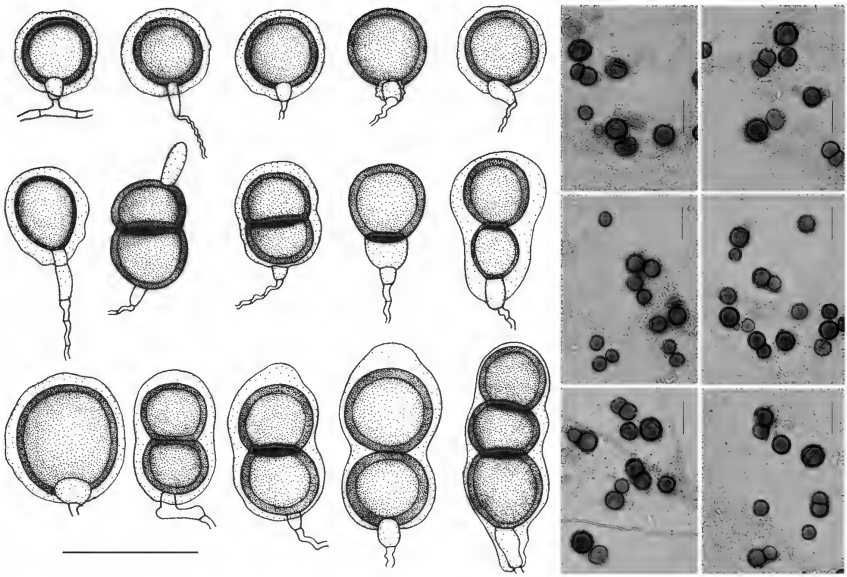

FIG. 1. *Humicola jilongensis* (ex holotype).
Conidia, conidiophores and conidiogenous cells. (Bars = 25 μm).

Humicola jilongensis Y.M. Wu & T.Y. Zhang, **sp. nov.** FIG. 1

MYCOBANK MB 563887

Differs from *H. globosa* and *H. indica* by its larger conidia with numerous melanin granules giving a rough appearance to the conidia.

TYPE: China, Tibet: Jilong, from a mountain soil, altitude 4550 m, 20 Sept. 2007, Y.M. Wu (**Holotype** HSAUP II $_{07}$1485; **isotype** HMAS 196260).

ETYMOLOGY: in reference to the type locality.

Colonies on PDA at 26°C for 7 days 3–5 cm diam., effuse, velvety, brown to dark brown. Mycelium superficial or immersed: hyphae branched, septate, smooth, subhyaline to light brown, 2–3 μm wide. Conidiophores subhyaline to light brown, mononematous, septate, smooth, 3–7 μm wide. Conidia globose, solitary or forming short chains, golden-yellow, thick-walled, 15–24 (commonly 19) μm in diameter, covered by numerous melanin granules giving the conidial surface a rough appearance. Chlamydospores intercalary, globose. Phialospores not seen.

COMMENTS –Morphologically, *H. jilongensis* resembles *H. globosa* De Bert. (De Bertoldi 1976) and *H. indica* S.C. Agarwal (Agarwal 1983; nom. illegit., non Haware & Pavgi 1971) but its conidia are larger than those of *H. globosa* (12–13 μm) or *H. indica* (8–10 μm). In addition, *H. jilongensis* conidia are covered by

numerous melanin granules giving the conidial surface a rough appearance, while the conidia of *H. indica* are slightly roughened and those of *H. globosa* are smooth.

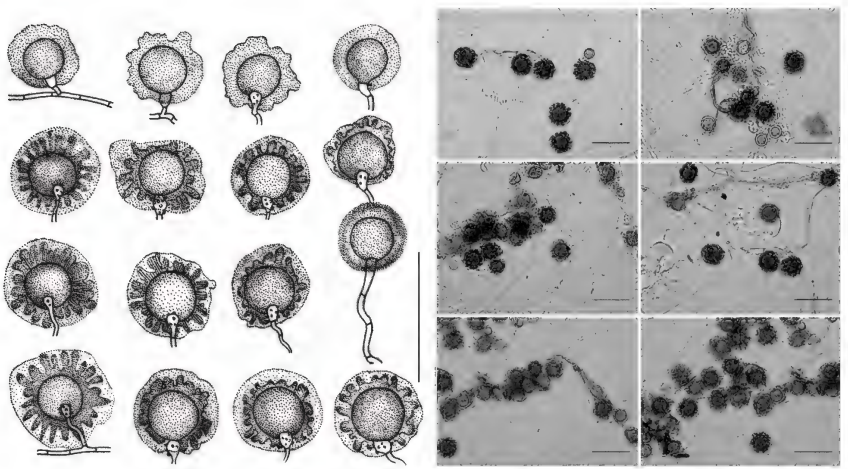

Fig. 2. *Humicola shannanensis* (ex holotype).
Conidia, conidiophores and conidiogenous cells. (Bars = 25 μm).

Humicola shannanensis Y.M. Wu & T.Y. Zhang, **sp. nov.** Fig. 2

MycoBank MB 563889

Differs from *Humicola lutea* by its verrucose conidia.

Type: China, Tibet: Shannan, from a grassland soil, altitude 3850 m, 28 Jun. 2007, Y.M. Wu (**Holotype** HSAUP II $_{07}$0597; **isotype** HMAS 196262).

Etymology: in reference to the type locality.

Colonies on PDA at 26°C for 7 days 2–3 cm diam., effuse, velvety, greyish brown to dark brown. Mycelium superficial and immersed: hyphae branched, septate, smooth, subhyaline to light brown, 1–3 μm wide. Conidiophores subhyaline, mononematous, septate, verrucose above, 3–5 μm wide. Conidia solitary, apical and lateral, globose, verrucose, golden-yellow, 8–10 (commonly 9) μm in diameter, thin-walled, surrounded by many melanin granules, forming a pile or coat (3–5 μm) thick. Phialospores not seen.

Comments –*Humicola shannanensis* is similar to *H. lutea* De Bert. (De Bertoldi 1976) in conidium size, but *H. lutea* has smooth conidia.

Endophragmiella zhangmuensis Y.M. Wu & T.Y. Zhang, **sp. nov.** Fig. 3

MycoBank MB 563891

Differs from *Endophragmiella theobromae* by its smaller, 1-septate conidia, and from *E. ovoidea* by its narrower conidia.

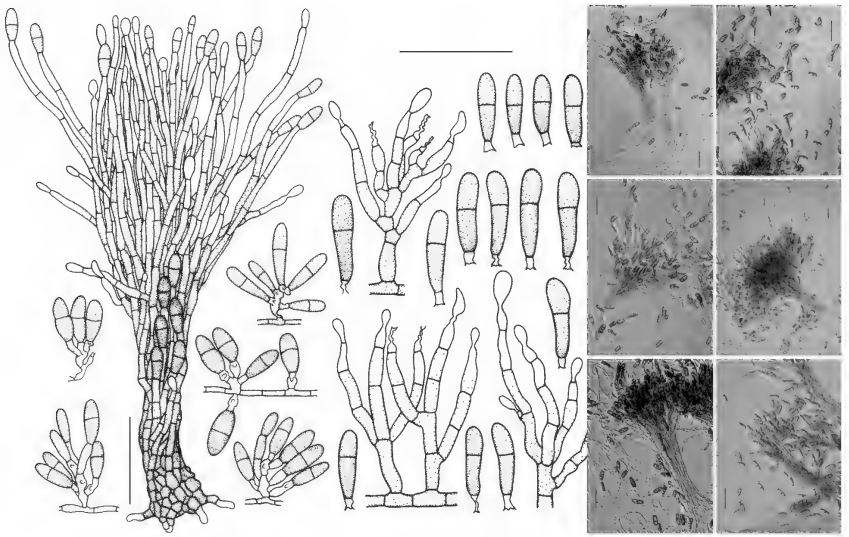

FIG. 3. *Endophragmiella zhangmuensis* (ex holotype).
Conidia, conidiophores and conidiogenous cells. (Bars = 25 μm).

TYPE: China, Tibet: Zhangmu, from a grassland soil, altitude 2250 m, 14 Sept. 2007, Y.M. Wu (**Holotype** HSAUP II $_{07}$1249; **isotype** HMAS 196263).

ETYMOLOGY: in reference to the type locality.

Colonies on PDA at 25°C for 7 days 3–5 cm diam., effuse, hairy, dark blackish brown to black. Mycelium superficial and immersed: hyphae branched, septate, pale brown, smooth, 2–4 μm wide. Conidiophores macronematous, synnematous or mononematous, erect, straight or flexuous, smooth, septate, light brown, paler towards the apex, 40–200 × 3–5 μm. Conidiogenous cells monoblastic, integrated, terminal, percurrent, cylindrical, tapered to a truncate apex. Conidia mostly clavate, smooth, 1-septate, pale brown, with a small and protuberant thin-walled peg at the base, 15–20 × 3–5 μm.

COMMENTS – In conidial shape, *E. zhangmuensis* resembles *E. theobromae* M.B. Ellis (Ellis 1976) and *E. ovoidea* P.M. Kirk (Kirk 1981), which differ in conidial dimensions (16–30 × 8–11 μm in *E. theobromae* and 14–16 × 5.5–6.5 μm in *E. ovoidea*). In addition, the conidia of *E. theobromae* are 2–3-septate while those of *E. ovoidea* and *E. zhangmuensis* are 1-septate.

Acknowledgments

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Pholiota virescens, a new species from China

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Abstract — *Pholiota virescens*, a new species of *Pholiota* is described from China. It is characterized by its pileus with the green tone at maturity, and its prominent and conspicuously projecting pleurocystidia with thin wall.

Key words — *Agaricales*, *Strophariaceae*, taxonomy

Introduction

Pholiota (Fr.) P. Kumm. (*Agaricales*, *Strophariaceae*), established by Kummer in 1871, is a widespread genus (especially in the North Temperate Zone) with about 150 species worldwide (Kirk et al. 2008; Smith & Hesler 1968; Holec 2001; Noordeloos 2011).

There have been 55 taxa of *Pholiota* recorded in China (Tian & Bau 2004, 2005, 2011a,b; Bau et al. 2005), among which 20 species are edible (Dai et al. 2010) and 9 species are medicinal (Dai & Yang 2008). Recently, an additional new species was discovered during the research on the genus based on morphological examinations of collections.

Materials & methods

Specimens were examined by traditional taxonomic methods (Singer 1975). 5% KOH solution and Melzer's reagent were used as the mountants when examining the microstructure. Morphological characteristics of the species were described and illustrated according to the observations on the materials. Colour description for the new species refer to Kornerup & Wanscher (1978). The specimen studied is now deposited in the Herbarium of Mycology of Jilin Agricultural University (HMJAU).

Taxonomy

Pholiota virescens T. Bau & E.J. Tian, **sp. nov.** Plate 1, Figure 1

MycoBank MB563114

Differs from *Pholiota velaglutinosa* by the green tone of its mature pileus and by the thin-walled pleurocystidia.

PLATE 1 *Pholiota virescens*.
Habit.

TYPE: China, Jilin Province, Hunchun City, Shengli Village, 5 km to the east, on decayed hardwood, 10 July 2010, Tolgor Bau & En-Jing Tian (**Holotype**, HMJAU 22498).

ETYMOLOGY: The species epithet *virescens* refers to the pileus color becoming green with maturity.

PILEUS 2.8–6.4 cm broad, convex, then becoming plane, even at the margin, viscid, dull vinaceous-brown over the disc at first, but becoming dull green towards the margin, glabrous except for brown floccose veil-remnants adhering along the margin. LAMELLAE adnate, near avellaneous, becoming dull cinnamon-brown to dull greenish-brown at maturity, dense, medium broad, edges even. STIPE 2–4.5 cm long, 0.4–0.5 cm thick, equal, solid, white above, becoming pale vinaceous to brownish below, dingy brown at base, with scattered patches of fibrils to fibrillose-squamulose below; Veil brown, fibrillose, evanescent, leaving an evanescent ring. CONTEXT thin, brownish, odor and taste mild. SPORE PRINT dull cinnamon-brown.

SPORES 6.2–7.2(–7.7) × 3.8–4.3(–5.3) μm, ellipsoid, oblong to ovate in face view, phaseoliform in side view, smooth, pale rusty to cinnamon-brown in KOH, slightly paler in Melzer's reagent, germ pore minute. BASIDIA 17–20 × 5–6 μm, (2–)4-spored, narrowly clavate, hyaline in KOH. CHRYSOCYSTIDIA absent. PLEUROCYSTIDIA 50–80 × 11–15 μm, fusoid-ventricose with obtuse to slightly acute apex, upper part elongated (up to 44 μm), wall thin, smooth, content homogeneous to collapsed, hyaline to tawny in KOH. CHEILOCYSTIDIA 24–44 × 8.5–10 μm, clavate, irregularly clavate to fusoid-ventricose, thin-walled, smooth, content homogeneous, hyaline to pale yellow in KOH. GILL TRAMA of parallel to subparallel hyphae hyaline in KOH and with smooth

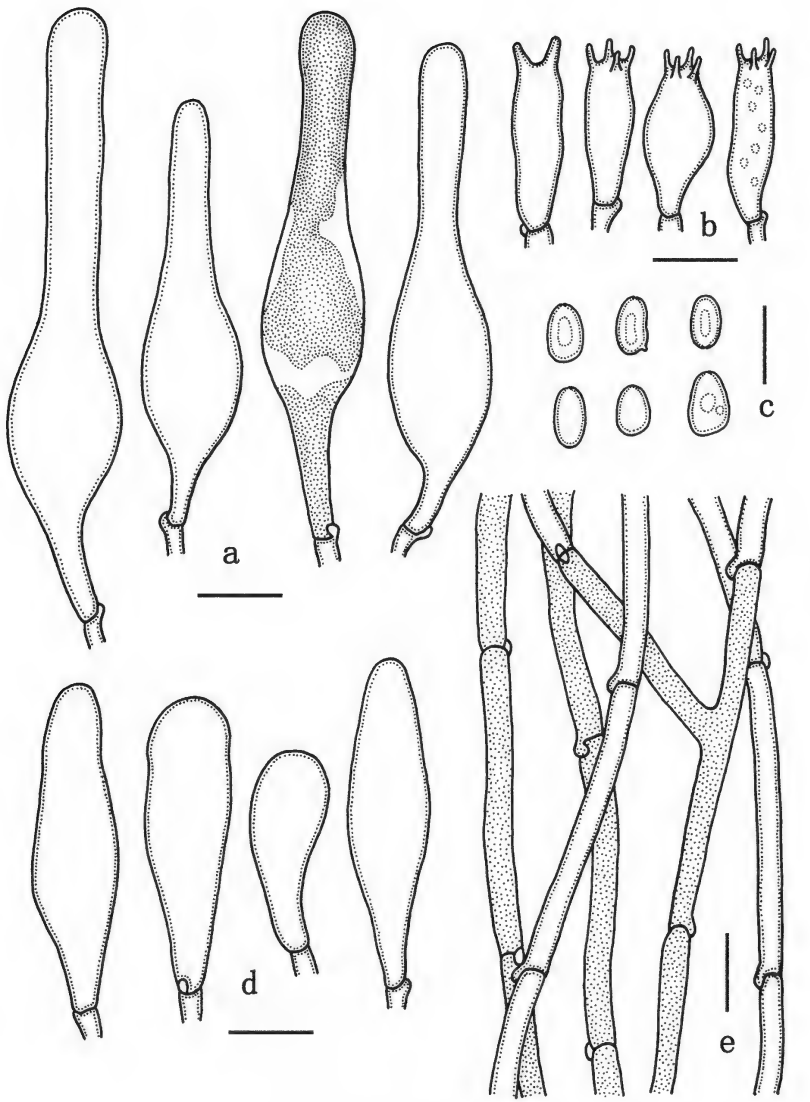

FIGURE 1 *Pholiota virescens*.
a, Pleurocystidia; b, Basidia; c, Basidiospores; d, Cheilocystidia; e, Pileipellis.
Bars = 10 μm.

walls, the cells inflated, up to 25 μm in diam.; subhymenium of gelatinized, interwoven hyphae. PILEUS CUTIS an ixocutis of hyphae 2.5–5 μm in diam., thin-walled, smooth to slightly encrusted, yellowish to pale tawny in KOH.

Context hyphae thin-walled, smooth, hyaline to yellowish in KOH. Clamp connections present.

Habit–Scattered on dead wood of hardwoods in summer.

Comments–This species belongs to the subgenus *Flammuloides* (Smith & Hesler 1968) based on its viscid pileus, prominent and conspicuously projecting cheilo- and pleurocystidia, and typically gelatinous subhymenium.

Pholiota virescens is similar to *P. velaglutinosa* A.H. Sm. & Hesler in young pileus color and basidiospore size and shape (Smith & Hesler 1968), but differs in the green tone in the mature pileus and the thin-walled pleurocystidia. It is also close to *P. vinaceobrunnea* A.H. Sm. & Hesler (Smith & Hesler 1968; Tian & Bau 2011a), which differs by its thick-walled pleurocystidia. *Pholiota lubrica* (Pers.) Singer is also similar, but its pileus is not dull vinaceous-brown but bright orange-brown (Noordeloos 1999; Holec 2001; Jacobsson 1990). *Pholiota velaglutinosa*, *P. vinaceobrunnea*, and *P. lubrica* are all known from China (Tian & Bau 2004, 2011a).

Acknowledgments

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Conocybe hausknechtii, a new species of sect. *Pilosellae* from the Western Caucasus, Russia

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Abstract — A new species, *Conocybe hausknechtii*, from the Western Caucasus, Russia is proposed here with detailed descriptions and illustrations.

Key words — *Bolbitiaceae*, taxonomy

Introduction

Members of the genus *Conocybe* Fayod are characterized by mycenoid habit, usually orange or brownish basidiocarp color, adnexed lamellae, lecythiform cheilocystidia, a hymeniderm pileipellis, and variously shaped spores usually with a prominent germ-pore (Arnolds 2005; Hausknecht 2009).

In an earlier study (Malysheva 2011) twenty-five species belonging to *Conocybe* were reported for the Western Caucasus. Detailed macroscopic and microscopic examination of two collections from this territory found some remarkable differences from known species; these collections are proposed as a new species.

Materials & methods

Material collected by the author from the Teberda State Biosphere Reserve (Western Caucasus, Russia) in August, 2009, was documented and dried using standard techniques. Macroscopic characters were recorded from fresh material in the field. Microscopic structures were determined from dried material observed under a light microscope Micmed 2-2 in squash preparations of small parts of the basidiocarp in 5% KOH. Size ranges for microstructures, except for basidiospores, are given based on measurement of at least 10 structures from each collection. In the descriptions of basidiospores, Q = mean length/width ratio of an individual spore and Q* = average Q from the total of 20 spores per collection. For observation of spore surface in Scanning Electron Microscopy (SEM), the spore material was prepared following Pegler & Young (1972). The images were captured using a "JEOL" JSM-6390LA Analytical Scanning Electron Microscope.

The specimens examined are deposited in the Mycological Herbarium of the Komarov Botanical Institute (LE). The nrITS sequences were submitted to GenBank.

PLATE 1. *Conocybe hausknechtii*: mature basidiocarps.

Taxonomy

Conocybe hausknechtii E.F. Malysheva, **sp. nov.** PL. 1–3

MYCOBANK MB 564193

Differs from *Conocybe rostellata* by its much wider pileus, stouter stipe, and slightly shorter spores.

TYPE: Russia, Karachaevo-Cherkesia, Teberda State Biosphere Reserve, vicinity of Teberda town, broad-leaved forest with *Fagus*, on strongly decayed wood of deciduous tree (probably *Fagus*), 6.VIII.2009, E. Malysheva (**Holotype**, LE 253789; GenBank JQ247194).

ETYMOLOGY: Named after Dr. Anton Hausknecht in honor of his exceptional contribution to knowledge of the *Bolbitiaceae*.

PILEUS 25–40 mm, at first obtusely conical with broad umbo, then conico-convex to applanate, hygrophanous, translucently striate to center when moist, in fresh condition pale to dark reddish brown, sometimes with ochraceous tint, slightly paler towards margin, in dry condition dull brown, clay-color to ochre, with center remaining darker, surface smooth or almost invisibly pruinose, especially at center; LAMELLAE moderately crowded, narrowly adnate, ventricose, pale yellow-brown to rusty brown, with concolorous edge and lamellulae; STIPE 40–50 × 3–4 mm, cylindrical or slightly thickened towards base, without distinct bulb, pale cream-yellowish or ochraceous at apex to yellow-brown or red-brown in lower part, longitudinally striate and entirely pubescent.

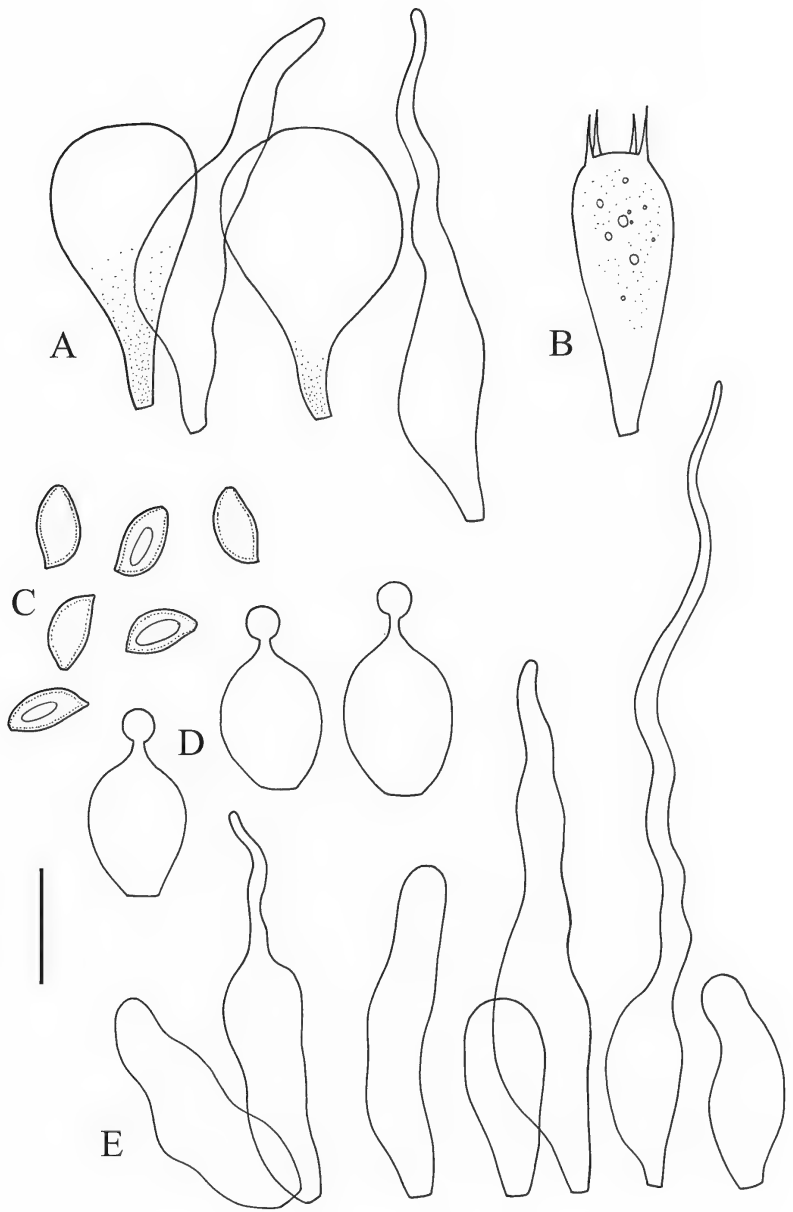

Plate 2. *Conocybe hausknechtii* (holotype): A – elements of pileipellis with pileocystidia; B – basidium; C – spores; D – cheilocystidia; E – caulocystidia. Scale bar = 10 μm.

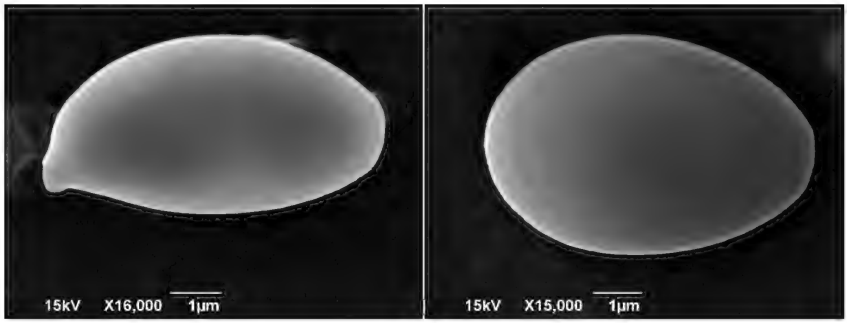

Plate 3. *Conocybe hausknechtii*: SEM photographs of spores.

Basidiospores 7.6–8.0 × 4.6–5.4 μm, Q = 1.6–1.7, Q* = 1.6, narrowly ellipsoid, some proportion limoniform to amygdaliform, not lentiform, sometimes papillate, with distinct germ-pore, pale yellow-brown in KOH, slightly thick-walled, smooth (even in scanning electron microscope); Basidia 4-spored, 27–30 × 8–12.5 μm, broadly clavate; Cheilocystidia lecythiform, 18–30 × 8–12 μm, with short neck and small head, 4–5.5 μm in diameter; Pileipellis a hymeniderm, consisting of clavate or spheropedunculate elements, 25–40 × 15–35 μm, often pigmented and thick-walled at base; Pileocystidia numerous, mostly lageniform with long flexuous neck, 37–55 × 5.5–8 μm, more rarely lecythiform with long neck and small head, 27–40 × 7–11 μm, thin-walled, hyaline or with yellow-brown content; Caulocystidia numerous, forming a continuous layer, variable in shape and size, mostly represented by long hyaline hairs ≤100 μm in length and <4 μm wide as well as lageniform, cylindrical, utriform or clavate elements, 12–60 × 8–14 μm; Clamp connections present.

Ecology & distribution — On strongly decayed wood of deciduous tree or on soil in forest. Only known from two places in the Western Caucasus.

Additional specimen examined — **RUSSIA, Karachaevo-Cherkesia**, Teberda State Biosphere Reserve, vicinity of Teberda town, mixed forest (with *Fagus*, *Carpinus*, *Pinus*), on soil, 7.VIII.2009, T. Svetasheva (LE 253998; GenBank JQ247195).

Discussion

Conocybe hausknechtii is characterized by the relatively dark basidiocarp color, strongly striate pileus, small limoniform or amygdaliform spores, presence of lageniform and lecythiform pileocystidia, and a stipitipellis lacking lecythiform caulocystidia. Based on this combination of characters, *C. hausknechtii* belongs to sect. *Pilosellae* Singer, series *Siennophylla* Hauskn. & Krisai [as "*Sienophylla*"] (Hausknecht, Krisai-Greilhuber 2006). Microscopically it is rather close to some species of the *C. siennophylla* group: *C. siennophylla*

(Berk. & Broome) Singer, *C. rostellata* (Velen.) Hauskn. & Svrček., and *C. ochrostriata* var. *favrei* Hauskn.

Conocybe siennophylla differs from *C. hausknechtii* mainly in brighter basidiocarp color, larger ellipsoid-ovoid (never limoniform) spores, and usually inconspicuous pileocystidia.

Conocybe rostellata is the species closest to *C. hausknechtii*, having similar shaped but slightly longer spores. It also differs from the new species by more slender habit and smaller basidiocarp size with a 5–27 mm broad pileus and stipe measuring 25–70 × 0.5–2 mm (Hausknecht 2009, Arnolds 2005).

Conocybe ochrostriata var. *favrei* differs from *C. hausknechtii* in its smaller and brighter colored basidiocarps, larger spores, and absence of pileocystidia.

The spore surface as seen in SEM shows that *C. hausknechtii* indeed is a member of the series *Siennophylla*, characterized by smooth spores.

Acknowledgments

I am grateful to Prof. A. Hausknecht for detailed examination of the holotype and valuable comments. I am also grateful to my reviewers, Prof. E. Arnolds, Prof. R.H. Petersen, and Prof. M. Prydiuk, for improving the text, to Prof. A.E. Kovalenko and staff of the Teberda State Biosphere Reserve for organization of the expedition and to L.A. Kartseva for help with making the SEM- photographs of spores. This research was supported by the Ministry of Education and Science of the Russian Federation (contract N 16.518.11.7071) and a grant of Russian Foundation for Basic Research (N 10-04-01189-a).

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Additions to the smut fungi of Pakistan. 1.

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Abstract — A new smut fungus, *Sporisorium pakistanense* on *Pennisetum lanatum,* is described and illustrated from Pakistan. Two species, *Bauhinus tenuisporus* on *Persicaria maculosa* and *Sporisorium dinteri* on *Bothriochloa bladhii,* are reported for the first time from Pakistan.

Key words — *Microbotryales,* taxonomy, *Ustilaginomycetes*

Introduction

During collecting trips for parasitic fungi in Mansehra District (Khyber Pakhtunkhwa Province, Pakistan), carried out by M. Fiaz in 2009–10, 20 specimens of smut fungi were collected. Based on the study of these specimens, we propose here a new smut fungus, *Sporisorium pakistanense* on *Pennisetum lanatum,* and report two records new for Pakistan: *Bauhinus tenuisporus* on *Persicaria maculosa* and *Sporisorium dinteri* on *Bothriochloa bladhii.*

Material & methods

Dried specimens from the Hazara University Herbarium (HUP), Pakistan were examined under light (LM) and scanning electron (SEM) microscopes. For LM observations, spores were mounted in lactophenol solution on glass slides, gently heated to boiling point to rehydrate the spores, and then cooled. Spore measurements are given in the form: min–max (mean ± 1 standard deviation). For SEM, spores were attached to specimen holders by double-sided adhesive tape and coated with gold with an ion sputter. The surface structure of spores was observed at 10 kV and photographed with a JEOL SM-6390 scanning electron microscope.

Taxonomy

Bauhinus tenuisporus (Cif.) Denchev & R.T. Moore, in Denchev et al., Mycologia Balcanica 3: 74, 2006. FIGS 1–2

≡ *Microbotryum tenuisporum* (Cif.) Vánky, *Mycotaxon* 67: 50, 1998.

SORI in swollen flowers; systemic infection, all flowers attacked. SPORE MASS powdery, purplish chestnut (based on the Anonymous (1969) Colour identification chart). SPORES globose, subglobose, broadly ellipsoidal or ovoid, 8–12.5 × 7.5–9.5 (9.7 ± 0.9 × 8.6 ± 0.6) µm (n = 50); wall 1.3–1.6 µm thick (incl. reticulum), reticulate, meshes irregularly polygonal, 4–5(–6) meshes per spore diameter, muri 0.8–1.3 µm high; in SEM the interspaces with a hemispherical tuberculum.

SPECIMEN EXAMINED — On *Persicaria maculosa* Gray: **PAKISTAN, KHYBER PAKHTUNKHWA PROVINCE,** Mansehra District, Dhodial Mansehra, October 2009, leg. M. Fiaz, no. FS–07 (HUP 301).

DISTRIBUTION — On *Persicaria* spp. (*Polygonaceae*), Asia, North & South America, Australia, and New Zealand (Vánky 2011). *Persicaria maculosa* is a new host record for this species.

Sporisorium dinteri (Syd. & P. Syd.) Vánky, Fungal Diversity 15: 232, 2004. FIGS 3–4

SORI destroying the whole inflorescence, ca. 2.5 cm long, partly hidden by the leaf sheath; initially covered by a yellowish brown peridium which later ruptures irregularly, exposing semi-agglutinated, dark reddish brown mass of spores and sterile cells surrounding a central, stout, simple or branching columella with longitudinal furrows. STERILE CELLS in chains or irregular groups, subglobose, broadly ellipsoidal or slightly irregular, sometimes collapsed, 6.5–12(–14) µm long, hyaline, wall 0.5–0.7 µm thick, smooth. SPORES subglobose, broadly ellipsoidal, ovoid or slightly irregular, 9–14 × 8.5–12.5 (11.9 ± 0.9 × 10.4 ± 0.9) µm (n = 50), yellowish brown; wall 0.5–0.7 µm thick, in LM densely echinulate, spore profile not or slightly affected, in SEM echinulate.

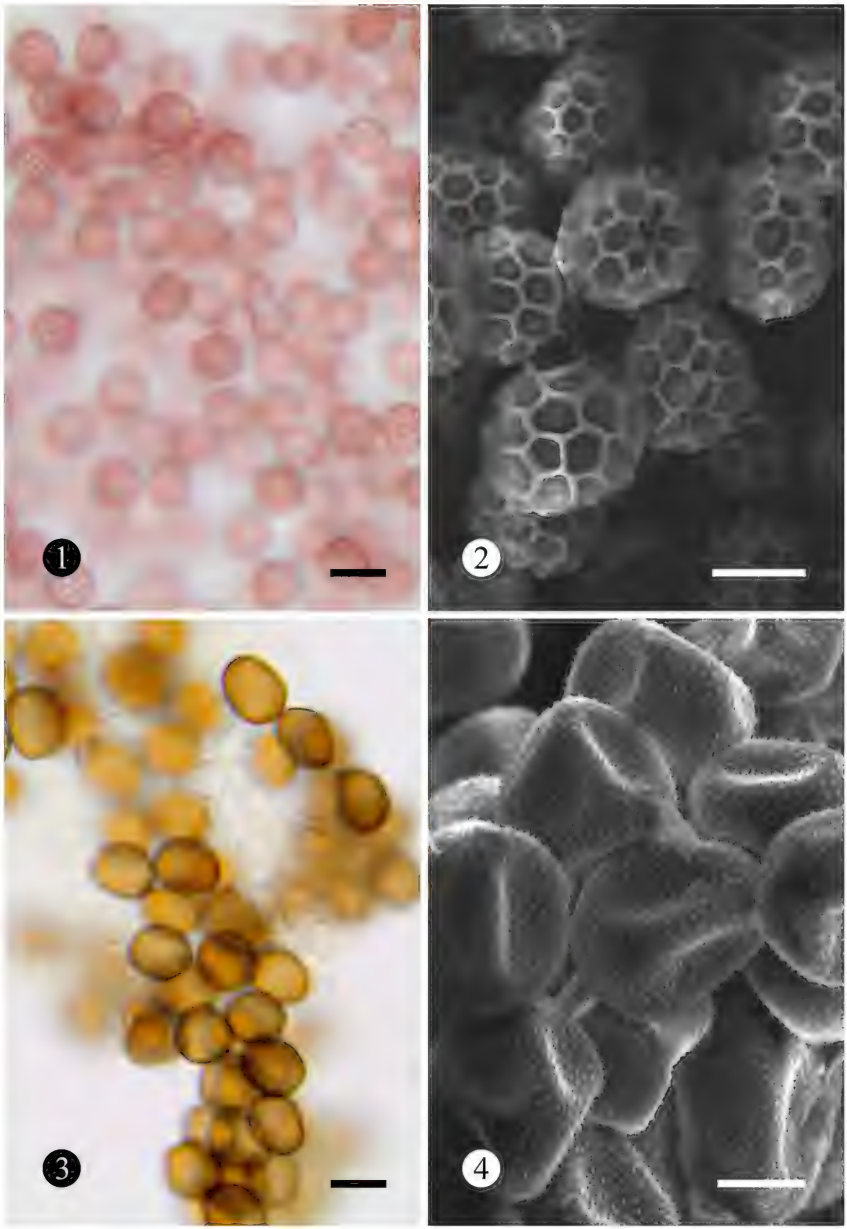
SPECIMEN EXAMINED — On *Bothriochloa bladhii* (Retz.) S.T. Blake: **PAKISTAN, KHYBER PAKHTUNKHWA PROVINCE,** Mansehra District, Damgala Mansehra, 3 September 2009, leg. M. Fiaz, no. FS–04 (HUP 302).

DISTRIBUTION — On *Bothriochloa* spp., *Dichanthium* spp. (*Poaceae*), South Asia, Africa, and Australia (Vánky 2011, Vánky et al. 2011).

Sporisorium pakistanense Denchev, T. Denchev & Fiaz, **sp. nov.** FIGS 5–6

MYCOBANK MB 564488

Differs from *Sporisorium cenchri* and *S. sphacelatum* by a central stout columella with longitudinal furrows and large spores, from *S. pennisetinum* by a single columella, and from *S. penniseticola* by a single columella and large spores.



Figs 1–2. Spores of *Bauhinus tenuisporus* on *Persicaria maculosa* (HUP 301) in LM and SEM.
Figs 3–4. Spores and sterile cells of *Sporisorium dinteri* on *Bothriochloa bladhii* (HUP 302) in LM and SEM. Scale bars: 1, 3 = 10 μm, 2, 4 = 5 μm.

Type on *Pennisetum lanatum* Klotzsch (*Poaceae*): Pakistan, Khyber Pakhtunkhwa Province, Mansehra District, Naran Jalkhud, August 2009, leg. M. Fiaz, no. FS–15 (**holotype**, SOMF 28 008; **isotype**, HUP 303).

Etymology: named after Pakistan, the country from which it was collected.

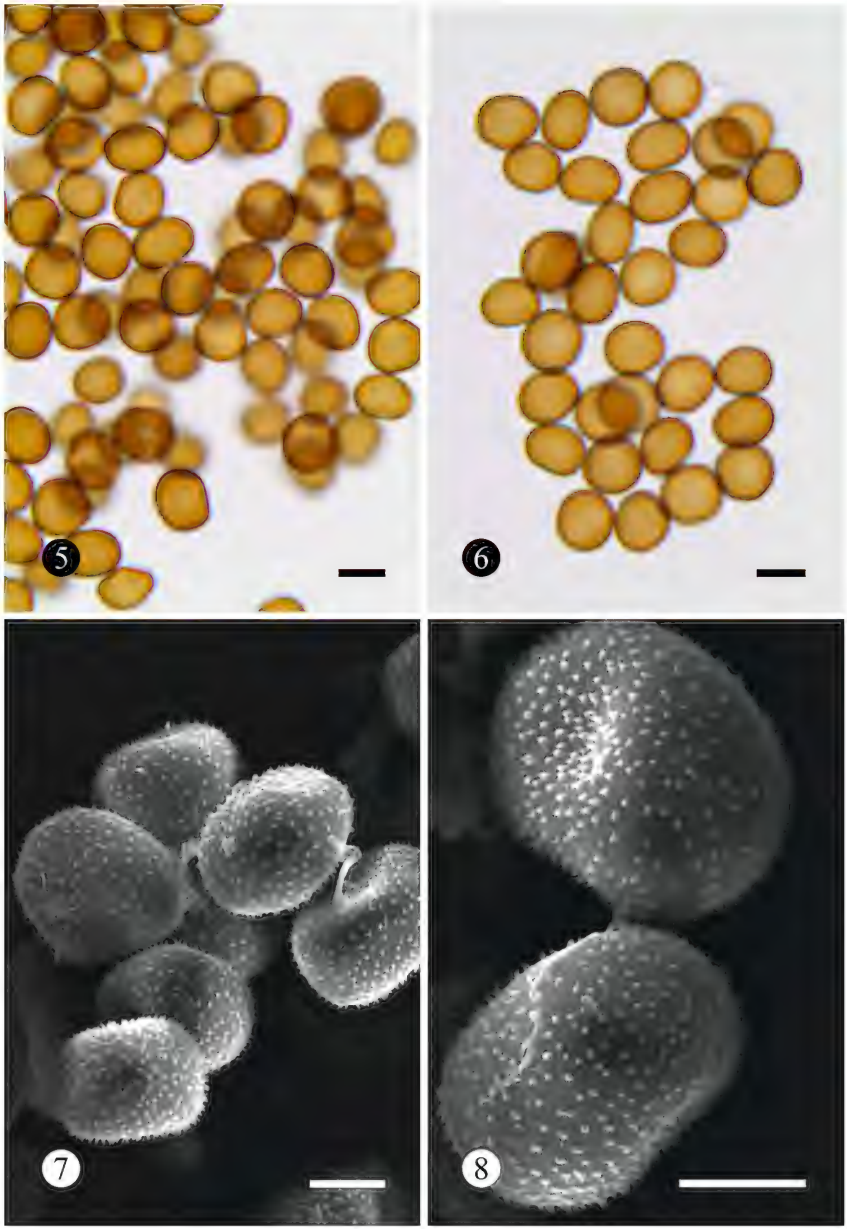
Sori destroying the distal part of sterile shoots, 1–3 cm long, 1.5–3 mm wide, partly hidden by the uppermost leaf sheath; initially covered by a greyish brown peridium which later ruptures irregularly, exposing semi-agglutinated, dark reddish brown spore mass surrounding a central, stout columella with longitudinal furrows. Spore balls and sterile cells not seen. Spores subglobose, broadly ellipsoidal, ellipsoidal, ovoid or slightly irregular, 11–15 × 9–12.5 (12.5 ± 0.8 × 10.5 ± 0.9) µm (n = 50), not dimorphic, light (to middle) reddish brown; wall 0.5–0.8 µm thick, in LM punctate to echinulate, spore profile slightly or not affected, in SEM echinulate.

Comments — Apparently, the spore balls of this *S. pakistanense* are early disintegrating.

Nine *Sporisorium* species have been described on *Pennisetum* (Vánky 2009, 2011). The sori of two of them, *S. ehrenbergii* (Kühner) Vánky and *S. tothii* Vánky, are restricted to the ovaries, while the sori of three species, *S. divisum* Vánky, *S. penniseti* (Rabenh.) Ershad, and *S. penniseti-japonici* (Henn.) Vánky, are restricted to the spikelets. The remaining species possess sori that destroy the whole inflorescence or are located on the top of sterile shoots: (i) *S. cenchri* (Lagerh.) Vánky on *Cenchrus* and *Pennisetum* spp., with type on *Cenchrus* sp. from Ecuador (sori destroying the whole inflorescence, with numerous, thread-like columellae; spore balls persistent, opaque; spores 8–13 µm long); (ii) *S. pennisetinum* (S. Ahmad) Vánky on *Pennisetum flaccidum* Griseb., known only from the type collection from Pakistan (sori destroying the whole inflorescence, with numerous, filiform columellae; spores densely verruculose-echinulate); (iii) *S. penniseticola* Vánky on *Pennisetum sphacelatum* (Nees) T. Durand & Schinz, known only from Ethiopia (sori on the top of sterile shoots, with several, slender columellae; spores (7.5–)8–11(–13) µm long); and (iv) *S. sphacelatum* Vánky, with type on *Pennisetum sphacelatum* from South Africa (sori on the top of sterile shoots, with several, long, filiform columellae; spores 5.5–7.5 µm long, darker on one side, where the wall is thicker).

Sporisorium pakistanense differs from *S. cenchri* and *S. sphacelatum* by having a central, stout columella with longitudinal furrows, and large spores.

We have not seen the type of *S. pennisetinum,* but based on its illustration in Vánky (2011: 708), the spore ornamentation of *S. pennisetinum,* as seen in SEM, consisted of more densely situated ornaments than those of *S. pakistanense;* moreover, the sori of *S. pennisetinum* have numerous, filiform columellae while these of *S. pakistanense* possess a central columella.



Figs 5–8. Spores of *Sporisorium pakistanense* on *Pennisetum lanatum* (holotype, SOMF 28 008) in LM and SEM. Scale bars: 5–6 = 10 µm, 7–8 = 5 µm.

The sori of *S. penniseticola* differ from these of *S. pakistanense* in being situated on the top of sterile shoots comprising the whole inflorescence and its stem, forming long, cylindrical, greyish brown bodies, 5–18 cm long, 1–3 mm wide, partly enclosed by the uppermost leaf sheath, at maturity, the distal part of the sori splits longitudinally in several places, after the dispersion of the spore balls with exposed long, slender columellae, whereas the proximal part of the sori is still entire containing sporogenous hyphae with immature spore balls (Vánky 2005: 93). Additionally, the spores of *S. penniseticola* are smaller.

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Two new microfungi from Portugal: *Magnohelicospora iberica* gen. & sp. nov. and *Phaeodactylium stadleri* sp. nov.

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Abstract — Two new microfungi are described and illustrated from a forest in Portugal. *Magnohelicospora iberica* gen. & sp. nov. is distinguished by polyblastic, integrated, sympodial conidiogenous cells and solitary, doliiform or conical, multi-euseptate, brown conidia tightly coiled in three planes. *Phaeodactylium stadleri* sp. nov. is characterized by obovoid to clavate, 0- to 2-septate, coarsely verruculose, subhyaline to very pale brown conidia. A key to accepted *Phaeodactylium* species is provided.

Key words — *Ammophila arenaria,* anamorphic fungi, leaf litter, systematics

During the twenty-fifth mycological foray for study of the Iberian mycobiota held in the Minho and Braga provinces of Portugal, two undescribed anamorphic fungi were collected, one in a forest, the other near a beach. Individual samples of plant material were placed in paper and plastic bags, taken to the laboratory, and treated using the methods of Castañeda (2005). Mounts were prepared in polyvinyl alcohol-glycerol (8 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of ×1000. Photomicrographs were obtained with a Zeiss AXIO imager M1 microscope (Göttingen, Germany). The pure culture was obtained by transferring single conidia observed under a stereo-microscope on to oatmeal agar in Petri dishes, then incubated at 25°C

under near-UV, 12 h alternating cycles of light/dark. One new genus and two new species are described below.

Taxonomy

Magnohelicospora R.F. Castañeda, Hern.-Rest., Gené & Guarro, **anam. gen. nov.**

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Differs from *Helicoon* and *Inesiosporium* by differentiated conidiophores; from *Rogergoosiella* by sympodial proliferations of the conidiogenous cells; and from *Troposporium* and *Laocoon* by differentiated conidiophores, polyblastic conidiogenous cells and brown pigmented conidiophores and conidia.

Type species: *Magnohelicospora iberica* R.F. Castañeda et al.

Etymology: Latin , *magno-*, meaning great, Latin, *-helicospora*, referring to the helicospore, a coiled conidium that may turn in one or more complete rotations in two or three dimensions.

Anamorphic fungi. Colonies on the natural substratum effuse, hairy, brown to dark brown. Mycelium superficial and immersed. Conidiophores macronematous, mononematous, erect, smooth or verruculose, brown to dark brown. Conidiogenous cells polyblastic, integrated, sympodial, flattened, indeterminate. Conidial secession schizolytic. Conidia solitary, tightly coiled in three dimensions, doliiform to conical, multi-euseptate, acrogenous to acropleurogenous, brown to dark brown or olivaceous, smooth or verrucose. Teleomorph unknown.

Magnohelicospora iberica R.F. Castañeda, Hern.-Rest., Gené & Guarro, **anam. sp. nov.** Figs. 1, 2

MycoBank MB563848

Differs from *Helicoon* spp., *Inesiosporium* spp., *Laocoon paradoxus Rogergoosiella roystoneicola,* and *Troposporium album* by its brown, differentiated conidiophores and sympodially proliferating conidiogenous cells.

Type: Portugal, Minho province, "Lagoas de Bertiandos", 41°46′N 8°38′W, C11/57, on rotten leaf of unidentified plant, 9 November 2011, R.F. Castañeda, M. Hernández-Restrepo, J. Gené & J. Mariné-Gené (**Holotype**, HAL 2447 F; **Isotype**, FMR 12184).

Etymology: Latin, *iberica*, in reference to the Iberian Peninsula.

Colonies on the natural substratum, effuse, hairy, hypophyllous, brown. Mycelium mostly immersed. Hyphae septate, branched, 2 µm diam., smooth, brown. Conidiophores macronematous, mononematous, erect, straight, simple, 3- to 5-septate, smooth, up to 150 µm tall, 5–8 µm wide at the base, brown below, pale brown towards the apex. Conidiogenous cells polyblastic, terminal, indeterminate, sympodially proliferating, 15–25 × 4–5 µm, integrated, pale brown. Conidial secession schizolytic. Conidia solitary, acrogenous or acropleurogenous, compactly circinate in three dimensions, doliiform to somewhat conical, with a truncate basal cell, 2–3 µm wide and

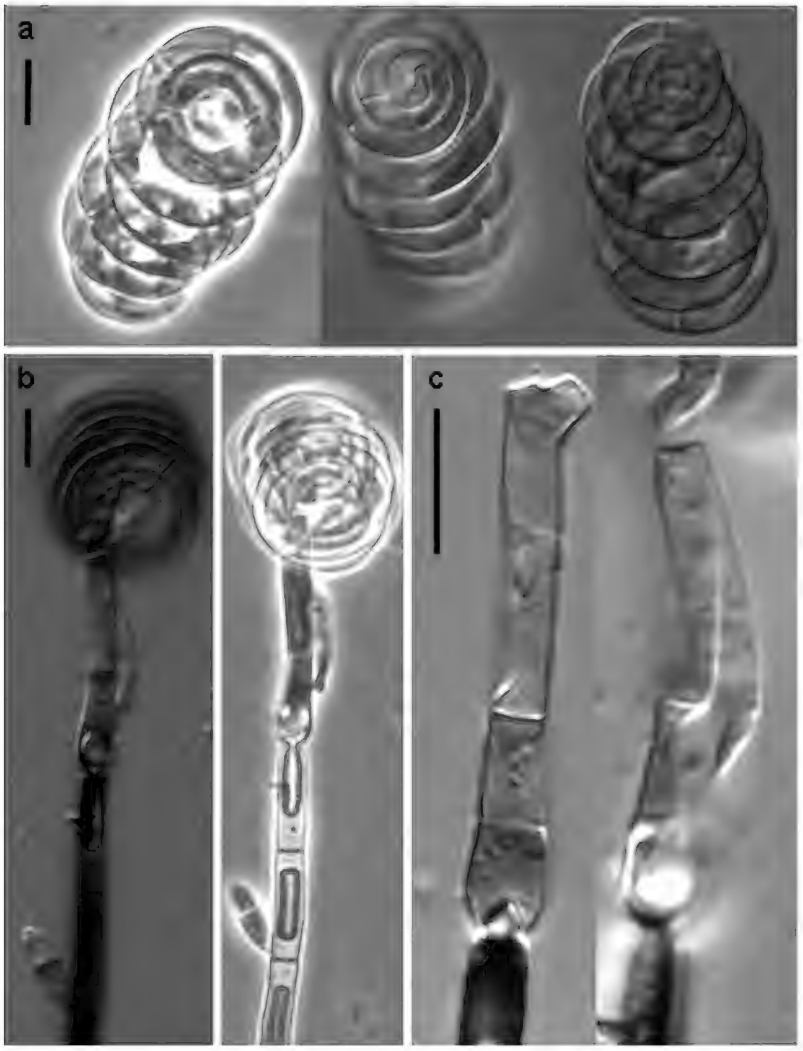

Fig. 1. *Magnohelicospora iberica* (ex holotype HAL 2447F)
a. Conidia. b. Conidiogenous cells and conidia. c. Conidiogenous cells. Scale bars = 10 µm.

rounded to obtuse apical cell, multiseptate, 35–50 × 23–30 µm, brown, smooth, dry, composed of filaments tightly coiled 7–9 times in 3-dimensions, brown or olivaceous-brown, euseptate, smooth, 4–5 µm wide. Teleomorph unknown.

Note: According to the key given by Kendrick in Seifert et al. (2011), the genera *Helicoon* Morgan, *Inesiosporium* R.F. Castañeda & W. Gams, *Rogergoosiella*

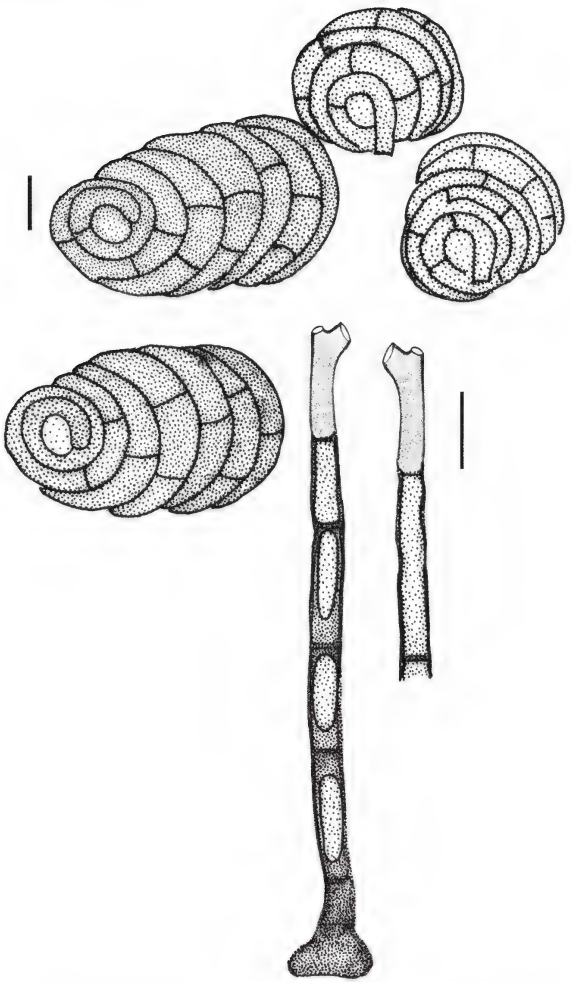

Fig. 2. *Magnohelicospora iberica* (ex holotype HAL 2447F).
Conidiophores, conidiogenous cells and conidia. Scale bars = 10 µm.

A. Hern. Gut. & J. Mena, and *Troposporium* Harkn. are superficially similar to *Magnohelicospora*. *Helicoon* does not have differentiated conidiophores, but the conidiogenous cells are polyblastic or monoblastic and denticulate, giving rise to euseptate, hyaline or dark pigmented conidia coiled in three planes (Zhao et al. 2007, Seifert et al. 2011). *Inesiosporium* has conidia strongly coiled in 3-dimensions and olivaceous to brown, but conidiophores are not differentiated and are mostly reduced to intercalary monoblastic conidiogenous cells each with a short subulate, lateral neck (Castañeda & Gams 1997, Zhao et al. 2007,

Seifert et al. 2011). *Rogergoosiella* is characterized by macronematous, simple or dichotomously branched dilute brown to hyaline conidiophores, with monoblastic, percurrently proliferating conidiogenous cells (Hernández-Gutiérrez & Mena 1996, Seifert et al. 2011). In *Troposporium* the conidiophores are undifferentiated, hyaline and bear monoblastic conidiogenous cells which produce hyaline, aseptate conidia coiled in 3-dimensions (Goos 1978, Seifert et al. 2011). The genus *Laocoon* J.C. David is also somewhat similar to *Magnohelicospora* but, *Laocoon* has conidia formed by filaments loosely coiled 1–5 times and the conidiogenous cells are polyblastic, each with a convex, cicatrized, melanized scar (David 1997), making them easy to differentiate from *Magnohelicospora*.

Phaeodactylium stadleri R.F. Castañeda, Hern.-Rest., Gené & Guarro, **anam. sp. nov.** FIGS 3–5

MycoBank MB563850

Differs from *Phaeodactylium alpiniae* by its smaller, mostly 1-septate, obovoid, truncate, verruculose conidia.

TYPE: Portugal. Braga: "Playa de Ofir", Esposende, C11/66, on decaying stem of *Ammophila arenaria* (L.) Link (*Poaceae*), 10 November 2011, R.F. Castañeda, M. Hernández-Restrepo, J. Gené & J. Mariné-Gené (**Holotype**, HAL 2448 F; ex-holotype culture, IMI 501220, CBS 132715, FMR 12185).

ETYMOLOGY: Latin, *stadleri*, in honor of Dr Marc Stadler (Helmholtz-Center for infection Research, Germany) who has collaborated with us in the study of fungal diversity.

COLONIES on the natural substratum caespitose to pustule-like or pilose, gray. Mycelium superficial and immersed. Hyphae septate, branched, smooth, very pale brown to subhyaline, 1–3 µm diam. CONIDIOPHORES macronematous, congested fasciculate, tree-like, more or less dichotomously branched, with branches 120–150 µm long, erect, straight or flexuous, slightly geniculate to sinuate, multiseptate, very pale brown at the base, subhyaline towards the apex, up to 200–280 × 4–8 µm, smooth. CONIDIOGENOUS CELLS polyblastic, denticulate, intercalary and terminal, subhyaline or hyaline, 10–30 × 2–3 µm, discrete, slightly geniculate, branched, indeterminate, with numerous holoblastic sympodial proliferations. Conidial secession schizolytic. CONIDIA solitary, acropleurogenous, mostly obovoid, truncate and delicately cicatrized at the base, (0–)1(–2)-septate, strongly verruculose, 13–18 × 5–6 µm, very pale brown to subhyaline, dry. Teleomorph unknown.

Culture from the holotype: Colonies on oat meal agar, attaining 20–28 mm after two weeks at 25°C, white to gray. Reverse white. Mycelium immersed or aerial, arachnoid. Hyphae thin-walled, septate, hyaline, 1.5–2 µm diam. Sporulation obtained after 2 weeks, conidia similar to those observed in nature, 1–2-septate, verruculose, 14–23 × 4–6 µm, subhyaline. Cultures deposited: IMI 501220, CBS 132715, and FMR 12185.

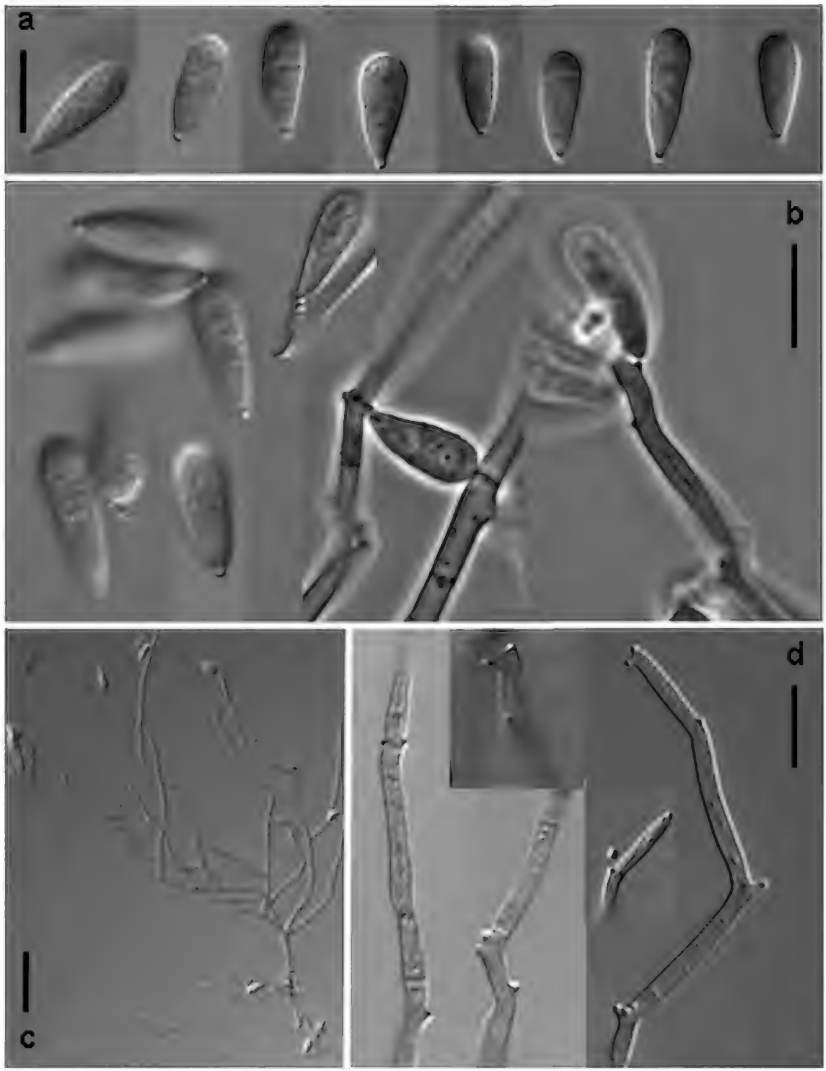

Fig. 3. *Phaeodactylium stadleri* (ex holotype HAL 2448F).
a. Conidia. b. Conidia and conidiogenous cells.
c. Conidiophore, conidiogenous cells and conidia. d. Conidiogenous cells.
Scale bars: a, b, d = 10 μm; c = 40 μm.

Note: The genus *Phaeodactylium* Agnihothr., as discussed by Castañeda et al. (2009), included three accepted species: *Phaeodactylium alpiniae* (Sawada) M.B. Ellis [= *P. venkatesanum* Agnihothr., the generic type], *P. biseptatum* R.F. Castañeda et al., and *P. curvularioides* Matsush. Another taxon *P. cephalotaxi*

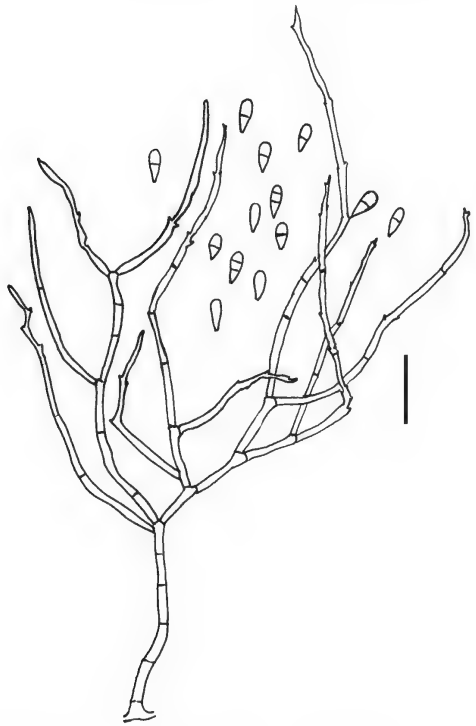

Fig. 4. *Phaeodactylium stadleri* (ex holotype HAL 2448F).
Conidiophores, conidiogenous cells and conidia. Scale bar = 40 µm.

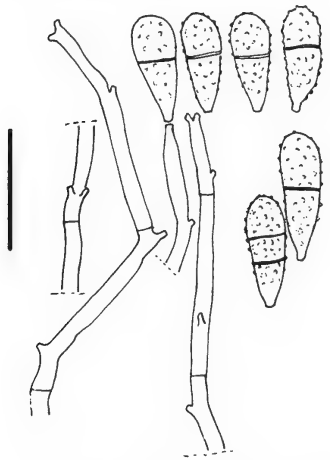

Fig. 5. *Phaeodactylium stadleri* (ex holotype HAL 2448F).
Conidiogenous cells and conidia. Scale bar = 10 µm.

Y.D. Zhang & X.G. Zhang has subsequently been added (Zhang et al. 2011). Only *P. alpiniae* is at all similar to *P. stadleri,* particularly in terms of the pigmentation of conidia, but *P. alpiniae* has conidia that are clavate, 16–25 × 6–9 µm, 3-septate and smooth, and the two taxa can be easily separated.

Key to accepted *Phaeodactylium* species

1 Conidia smooth-walled 2
Conidia closely verruculose, (0–)1–(–2)-septate, 13–18 × 5–6 µm, very pale brown to subhyaline ..... *P. stadleri*

2(1) Conidia 2-septate 3
Conidia 3-septate 4

3(2) Conidia clavate, fusiform or narrowly ellipsoid, but slightly ventricose at center, 10–14 × 2–3 µm, pale brown to subhyaline ..... *P. biseptatum*
Conidia narrowly ellipsoidal to clavate, pale brown to brown, 15–20.5 × 5–10 µm ..... *P. cephalotaxi*

4(2) Conidia ellipsoidal or clavate, tapered to the base, 16–25 × 6–9 µm, colorless or subhyaline, smooth ..... *P. alpiniae*
Conidia obovoid, 13–22 × 5–10 µm, with brown median cells and subhyaline ends, smooth ..... *P. curvularioides*

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Ellisembia karadkensis sp. nov. from southern Western Ghats, India

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Abstract— A new species, *Ellisembia karadkensis* is described from *Bambusa bambos* culms as a saprobe. It differs from other *Ellisembia* species in possessing simple or (often) Y-shaped branched conidia with long flagelliform apical appendages. A morphological comparison is made with similar *Ellisembia* species, and with those restricted to bamboo. A new combination, *E. magnibrachypus*, is proposed for *Sporidesmium magnibrachypus.*

Key words— anamorphic fungi, dematiaceous hyphomycete, Kerala

Introduction

Subramanian (1992) erected the genus *Ellisembia* during his reappraisal of *Sporidesmium* Link and morphologically similar taxa. Subramanian considered the type of septation of conidia, the nature, regularity and other features of the percurrent proliferations of conidiophores, and the presence and absence of conidiophores as important diagnostic criteria. Thus, *Ellisembia* with distoseptate conidia was separated from *Sporidesmium* with euseptate conidia, with *E. coronata* (Fuckel) Subram. (≡ *Sporidesmium coronatum* Fuckel) designated as type species (Subramanian 1992). After Ellis (1971, 1976) made significant studies on *Sporidesmium*, many distoseptate species were later transferred to *Ellisembia*. Wu & Zhuang (2005), who expanded the generic concept of *Ellisembia* to include species with typically lageniform, ovoid or doliiform percurrently extending conidiogenous cells, also synonymized *Imicles* Shoemaker & Hambl. (Shoemaker & Hambleton 2001) with *Ellisembia*. Shenoy et al. (2006) recognized that species of the *Sporidesmium* complex (including *Ellisembia*) were polyphyletic. Since Subramanian (1992) established the genus *Ellisembia*, 47 species epithets have been added (MycoBank 2012).

The pristine natural forests, microhabitats, and tropical warm humid climate that prevail in the Western Ghats make it rich and diverse in fungal diversity (Bhat & Kendrick 1993, Rajeshkumar 2007). During 2010–11, expeditions were conducted to explore the microfungal diversity in natural forests and plantations of southern and northern Western Ghats (Rajeshkumar et al. 2011a,b, Singh et al. 2010). During one survey, an unusual saprobic *Ellisembia* species (sensu Wu & Zhuang 2005) was discovered on bamboo culms.

Materials & methods

Isolates and morphology— Conidia of the fungus were directly isolated from the surface of a dead culm and observed under a Nikon binocular stereomicroscope (Model SMZ-1500 with Digi-CAM, Japan). Cultures from single conidia were established on 2% potato dextrose agar plates (PDA; Crous et al. 2009). For morphotaxonomic studies and photomicrographs, Carl Zeiss (AXIO Imager 2, Germany) and Olympus (Model CX-41, Japan) microscopes were used. Conidia and conidiophores were mounted in lactic acid cotton blue and measured using an ocular micrometer, with 30 observations per structure. The measurements were also confirmed with the software available with the Carl Zeiss (AXIO Imager 2, Germany) microscope. Colony characteristics in culture were studied on two different media: 2% malt extract agar (MEA) and PDA (Crous et al. 2009). Colony colours were determined using Methuen Hand book of Colour (Kornerup & Wanscher 1981). A herbarium specimen was deposited in the Ajrekar Mycological Herbarium (AMH); a culture was accessioned and preserved in the National Fungal Culture Collection of India (NFCCI [WDCM-932]), Agharkar Research Institute, Pune, India.

Taxonomy

Ellisembia karadkensis Rajeshkumar & S.K. Singh, **sp. nov.** Figs 1–2

MycoBank MB 564202

Differs from all other *Ellisembia* species by its simple or Y-shaped branched conidia with long flagelliform apical appendages.

Type: India, Kerala, Kasaragod, Karadka. On decaying culms of *Bambusa bambos* (L.) Voss, November 2011, K.C. Rajeshkumar (**Holotype,** AMH 9446; ex-type culture NFCCI 2664.)

Etymology: *karadkensis;* referring to the collection locality Karadka, a village in the Kasaragod District.

Colonies brownish black, erumpent, mycelium consisting of pale to dark brown, septate, thin-walled, smooth hyphae, 2–3.5 µm wide. Conidiophores macronematous, mononematous, stout, straight or flexuous, erect, dark to blackish brown, arising from creeping hyphae, 1–6-septate, 17.5–81 × 3.5–8 µm. Conidiogenous cells monoblastic, integrated, terminal, lageniform or cylindrical, pale or dark brown. Conidial secession schizolytic. Conidia solitary, simple or branched, obclavate, mostly curved, tapering towards narrow whip-

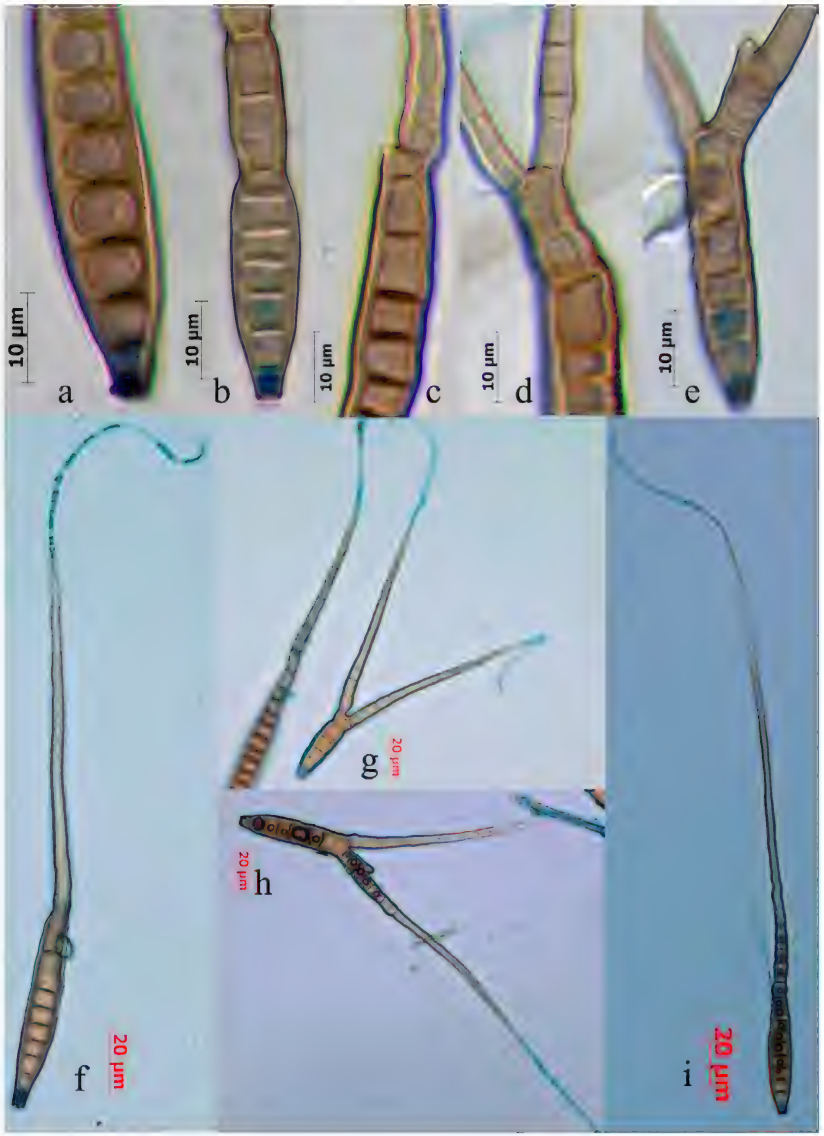

Fig. 1. *Ellisembia karadkensis* (holotype): a–b. Distoseptate conidial bases. c. Conidium with rudimentary branch initiation. d–e. Conidia with branches. f, i. Simple conidia with flagelliform apical appendages. g–h. Branched Y-shaped conidia.

like apical tip, 10–35-distoseptate, basal cells (up to 25th cell from base) are pale or olivaceous brown with dark septa, but apical cells are pale or hyaline with thin septa, walls thin and smooth; simple conidia, 150–345 × 9.5–12.5 µm,

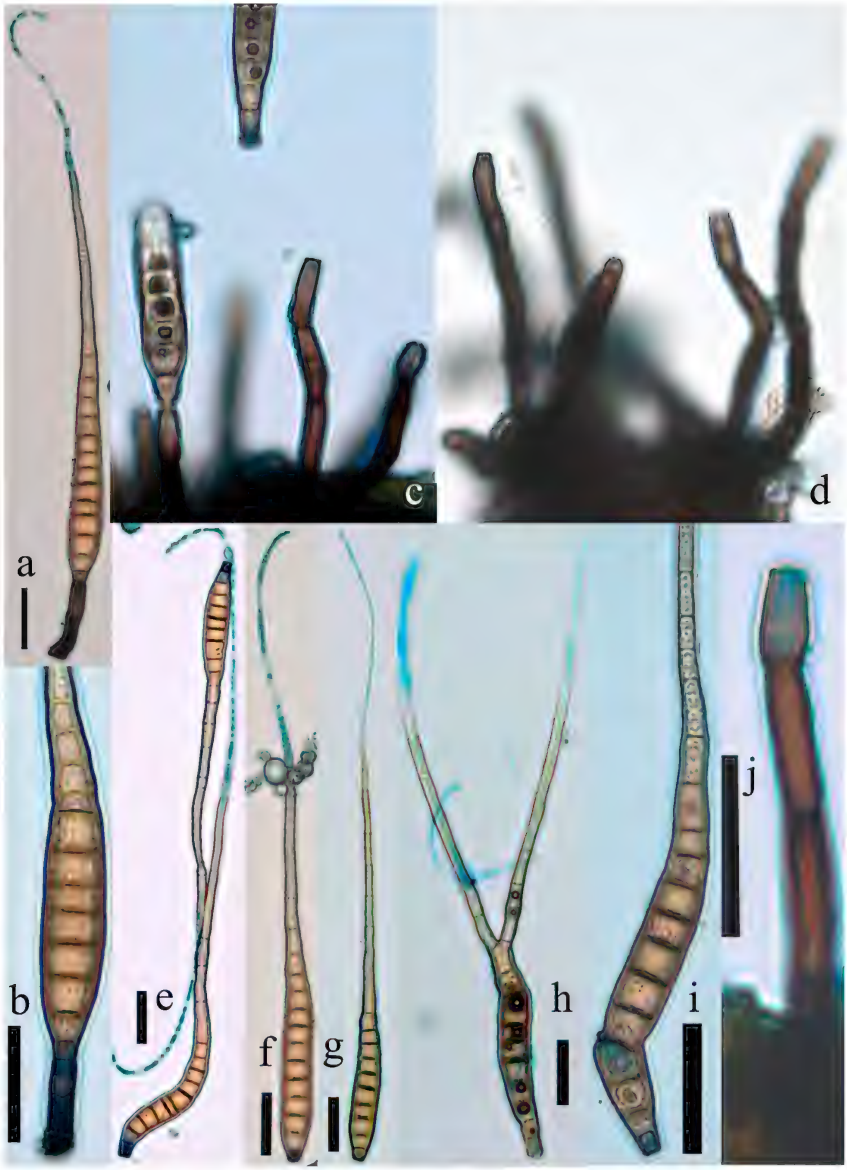

Fig. 2. *Ellisembia karadkensis* (holotype): a–b. Conidia attached to conidiophores. c–d. Conidiophores and conidial development. e–h. Variation in conidia. i. Conidium with curved base. j. Conidiophore with conidiogenous cell. Bars= 20µm.

conidial tip 1.5–2.7 µm wide, conidial base truncate, 3.2–5.5 µm wide; branched conidia Y-shaped, 190–250 × 9–10.7 µm, conidial tip 2–2.7 µm wide, conidial base 4–5.5 µm wide.

Teleomorph: not observed.

Colonies on PDA and MEA slow growing, 9–20 mm diam. at 25±2°C in 12 hours dark and 12 hours light conditions after 15 days, pale gray to dark gray (2D1), floccose, centrally umbonate; margin even; reverse dark grayish (1F1). Sporulation was not observed even after 30 days of growth.

Comments— Bamboo supports many *Ellisembia* species (McKenzie 1995, Mena et al. 2000, Wu & Zhuang 2005), and some species are known exclusively from *Bambusa* spp. These species are compared morphologically in Table 1.

Table 1. Comparison of *Ellisembia* species recorded on bamboos

Species	Conidiophores (µm)	Conidia (µm)	Source
E. bambusae	30–70 × 4–5	65–100 × 14–16, base 3–4.5	Wu & Zhuang (2005)
E. bambusicola	55–105 × 4–7	65–125 × 11–14, base 4–4.5	Mena-Portales et al. (2000)
E. bambusina	33–120 × 4.5–5.5	33–48 × 9–12, base 3–4	McKenzie (1995)
E. karadkensis	17.5–29.5 × 5.3–6.4	150–345 × 9.5–12.5, base 3.2–5.5	This paper

The conidia of *Ellisembia karadkensis* are morphologically similar to those of *E. podocarpi* Jian Ma & X.G. Zhang, *E. photiniae* Jian Ma & X.G. Zhang, *E. flagelliformis* (Matsush.) W.P. Wu, and *E. magnibrachypus* [≡ *Sporidesmium magnibrachypus*] (Matsushima 1975, Ma et al. 2010) in shape —especially in possessing simple hyaline flagelliform apices— and coloration. However, *E. karadkensis* conidia are longer and the Y-shaped branches have not been observed in these other species. The conidia of *E. magnibrachypus* may branch, but only in the hyaline, non-septate apical part (Matsushima 1975), whereas, in *E. karadkensis*, branched conidia are Y-shaped with a hyaline distoseptate apical tip. *Ellisembia magnibrachypus* also has shorter conidia (48–62 µm, excluding apical appendages that are ≤ 65 µm long; Matsushima 1975); in that species Matsushima (1975) considered the apical hyaline non-septate region as an apical appendage.

Neither Subramanian (1992) nor Wu & Zhuang (2005) considered *S. magnibrachypus* in their reassessments of *Sporidesmium,* even though it is a distoseptate species. Therefore, we propose a new combination here.

Ellisembia magnibrachypus (Matsush.) Rajeshkumar & S.K. Singh, **comb. nov.**

MycoBank MB 564216

≡ *Sporidesmium magnibrachypus* Matsush., Icon. Microfung. Matsush. Lect.: 138. 1975.

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Mycoacia angustata sp. nov. (*Basidiomycota, Meruliaceae*), the first Chinese hydnoid species

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Abstract — A new hydnoid basidiomycete, *Mycoacia angustata* sp. nov., is described and illustrated from the tropical and subtropical forest of Hainan and Hubei Province, southern China. It is the first new *Mycoacia* species described from China. The new species is characterized by ceraceous basidiocarps, an odontioid to hydnoid hymenophore with buff to cinnamon-buff surface, a monomitic hyphal system, and allantoid narrow hyaline basidiospores. Relationships between the new and closely related species are discussed.

Key words — *Polyporales*, wood-decaying fungi, taxonomy

Introduction

Mycoacia Donk was described by Donk based on the type species *Hydnum fuscoatrum* Fr. The genus is characterized by ceraceous fruitbodies with a hydnoid hymenophore with conical to cylindrical spines, monomitic hyphal system, and narrowly ellipsoid, cylindrical, or allantoid basidiospores (Eriksson & Ryvarden 1976). *Mycoacia* comprises species with a distinctly hydnoid hymenophore but is closely related to *Phlebia* Fr., which mostly comprises phlebioid species. Of the approximately 20 species encompassed in this genus at present, three have been reported from China (Dai 2011).

China is very rich in wood-decaying fungi. Species diversity, taxonomy, phylogeny, ecology and economically important wood-decaying species have been recently studied extensively (Dai 2010, 2011, 2012, Dai et al. 2009, Zhou & Dai 2012), and a number of new basidiomycetes in subtropical and tropical forests have been described (Cui & Dai 2008, Cui et al. 2011, Dai et al. 2010, Dai & Li 2010, Li et al. 2008, Wei & Dai 2008, Zhou & Dai 2008).

During the most recent surveys of the wood-decaying fungi in southern China, three specimens of *Mycoacia* were collected from fallen angiosperm

trunks. Here we describe and illustrate them as a new species. The relationships between the new species and its closely related species are discussed.

Materials & methods

The specimens are deposited at the biological herbarium of Institute of Applied Ecology, Chinese Academy of Sciences (IFP). The microscopic examinations followed Dai (2010) and were performed on sections mounted in Cotton Blue (CB): 0.1 mg aniline blue dissolved in 60 g pure lactic acid; CB+ = cyanophilic, CB– = acyanophilic. Amyloid and dextrinoid reactions were tested in Melzer's reagent (IKI): 1.5 g KI (potassium iodide), 0.5 g I (crystalline iodine), 22 g chloral hydrate, aq. dest. 20 ml; IKI– = neither amyloid nor dextrinoid reaction. 5% KOH was used as reagent. Sections were studied at magnifications up to ×1000 using a Nikon Eclipse E600 microscope and phase contrast illumination, and dimensions were estimated to an accuracy of 0.1 μm. The apiculus was excluded from the spore measurements, and 5% of the spore dimensions at each end of the range are shown in parentheses. Abbreviations include: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = extreme values of the length/width ratios among the studied specimens, and n = the number of spores measured from a given number of specimens. Special color terms are from Petersen (1996).

Taxonomy

Mycoacia angustata H.S. Yuan, **sp. nov.** FIGURE 1

MYCOBANK MB 800172

Differs from *Mycoacia subconspersa* by its darker hymenophore color, its longer, more widely spaced spines, and its longer basidiospores.

TYPE — China. Hainan Province, Changjiang County, Bawangling Nature Reserve, on fallen angiosperm trunk, 12.XII.2007, Yuan 3963 (**holotype**, IFP).

ETYMOLOGY — *angustata* (Lat.): referring to the narrow basidiospores.

FRUITBODY — Basidiocarps annual, resupinate, adnate, ceraceous, without special odor or taste when fresh, brittle when dry, up to 18 cm long, 5 cm wide and 2 mm thick; sterile margin white, narrow or almost lacking. Hymenophore odontioid to hydnoid, buff when fresh, cinnamon-buff to yellowish brown upon drying; spines crowded, evenly distributed, 3–4 per mm, ceraceous when young, corneous when old, cylindrical, with obtuse or acute apices, mostly individual, occasionally confluent, up to 1 mm long. Subiculum homogenous, azonate, cream to buff, 0.5–1 mm thick.

HYPHAL STRUCTURE — Hyphal system monomitic; generative hyphae bearing clamp connections or simple septa, IKI–, CB–; tissue unchanged in KOH.

SUBICULUM — Generative hyphae hyaline, bearing clamp connections or simple septa, thin- to thick-walled, occasionally with short side-branches, frequently branched at right angles, loosely interwoven, mostly 3–6 μm diam, occasionally inflated up to 12 μm diam.

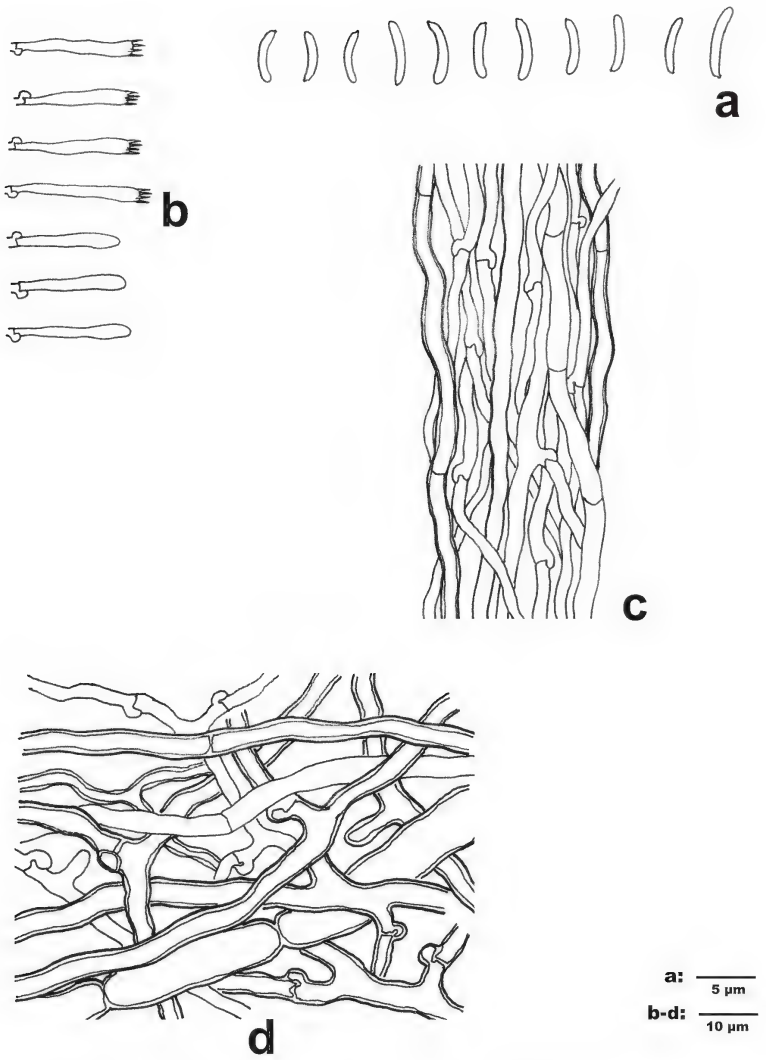

FIGURE 1. Microscopic structures of *Mycoacia angustata* (holotype).
a: Basidiospores. b: Basidia and basidioles.
c: Hyphae from spine trama. d: Hyphae from subiculum.

TUBES — Generative hyphae hyaline, bearing clamp connections or simple septa, thin- to slightly thick-walled, occasionally branched, subparallel to interwoven, 2–5 µm diam. Cystidia absent; basidia narrowly clavate, bearing four sterigmata and a clamp connection at the base, 16–23 × 2.7–3.1 µm; basidioles in shape similar to basidia, but slightly smaller.

Spores — Basidiospores, narrowly allantoid, hyaline, thin-walled, smooth, IKI–, CB–, (4.7–)4.8–6.5(–7.2) × (0.9–)1–1.2 μm, L = 5.52 μm, W = 1.07 μm, Q = 4.83–5.51 (n = 60/2).

Additional specimens examined — **CHINA. Hainan Province**, Changjiang County, Bawangling Nature Resever, on fallen angiosperm trunk, 13.XII.2007, Yuan 4001 (IFP); **Hubei Province**, Wufeng County, Houhe Nature Reserve, on fallen angiosperm trunk, 28.IX.2004, Wei 2273 (IFP).

Remarks — *Mycoacia angustata* is characterized by annual resupinate ceraceous basidiocarps, odontioid to hydnoid, buff, cinnamon-buff to yellowish brown hymenophore with white margin, presence of both clamp connections and simple septa, narrowly allantoid basidiospores, and absence of cystidia. It is closely related to *Mycoacia aurea* (Fr.) J. Eriksss. & Ryvarden, *M. uda* (Fr.) Donk, and *M. subconspersa* (Rick) Hjortstam & Ryvarden.

Mycoacia aurea also is characterized by a yellow-ochraceous hymenophore surface, absence of cystidia, and allantoid to suballantoid basidiospores. However, it is distinguished from *M. angustata* by its longer spines (2–3 mm) and wider basidiospores (3.5–5.5 × 1.5–2 μm) (Eriksson & Ryvarden 1976).

Mycoacia uda resembles *M. angustata* in having sordidly yellow to ochraceous basidiocarps when old and conical to subcylindrical spines that are 1–2 mm long. However, *M. uda* can be differentiated by the presence of subfusiform cystidioles that are apically capped with non-crystalline matter, rod-like crystals in the spine trama, and narrowly ellipsoid basidiospores. Moreover, parts of the young basidiocarp turn deep red in KOH (Eriksson & Ryvarden 1976).

Mycoacia subconspersa also has similarly shaped basidiospores but differs from *M. angustata* by having more crowded (5–8 per mm) and shorter (0.25–0.4 mm long) spines, paler hymenophore color, and shorter basidiospores (4–4.5 × 1–1.25 μm) (Hjortstam & Ryvarden 1982).

Other specimens examined: *Mycoacia aurea* — **SPAIN. Navarra Province**, Lekunberri, about 30 km NW of Pamplona, on *Quercus*, 11.XI.1977, Ryvarden 15230 (O); **USA. Tennessee**, Great Smoky Mts. National Park, Sugarland primitive campground, substrate unknown, 6.IX.1977, Ryvarden 14096 (O).

M. subconspersa — **CHINA. Yunnan Province**, Mengla County, Xishuangbanna Botanic Garden, on fallen angiosperm trunk, 30.IX.1993, 48251 (HKAS).

M. uda — **ESTONIA. Pärnu**, Nigula Nature Reserve, on *Pinus*, 26.VIII.1989, Ryvarden 27103 (O).

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A new species of *Entoloma* from Liaoning Province, Northeast China

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Abstract —*Entoloma liaoningense,* a new species from Northeast China, is described, illustrated, and discussed. It is characterized by mycenoid to marasmioid basidiomata, conspicuously sulcate pileus, 2-spored basidia, isodiametric to subisodiametric basidiospores, and absence of both cystidia and clamp connections.

Key words — *Agaricales, Basidiomycota, Entolomataceae*, taxonomy

Introduction

Entoloma (Fr.) P. Kumm. (*Entolomataceae, Agaricales, Basidiomycota*) is a large genus that is widely distributed from tropic to temperate regions. Representatives of this genus are distinguished by their basidiospores that appear angular in all views. The genus has been extensively studied in Europe, North America, Africa, Indomalaya, and Australasia (Hesler 1967; Horak 1980, 2008; Gates & Noordeloos 2007; Largent 1994; Noordeloos 1992, 2004; Noordeloos & Gates 2009; Romagnesi & Gilles 1979).

During a preliminary study on the entolomataceous mycota in Liaoning Province, China, five specimens of an *Entoloma* species were collected from Benxi Laotudingzi Nature Reserve, which proved to represent a new species. It is formally described and discussed here.

Materials & methods

Specimens were collected from Laotudingzi Nature Reserve located in east Liaoning Province of Northeast China, at 41°16′38″–41°21′10″N 124°49′06″–124°57′08″E at an altitude of 600–1367 m. Fresh collections were photographed. Macro-morphological

descriptions are based on field notes and photos. Color notations are according to Kornerup & Wanscher (1978). Micro-morphological data were obtained from dried material examined under a light microscope. Basidiospores, basidia, pileipellis, and stipitipellis were observed in 5% KOH or 1% Congo Red, and KOH-soluble pigments were determined in distilled water mountants. All measurements were made in 5% KOH. For basidiospore dimensions, Q = "length/width ratio" of a basidiospore in side view, Q_m = average Q ± standard deviation. Basidiospore dimensions exclude the hilar appendix. The studied specimens are deposited in the Herbarium of Jilin Agricultural University (HMJAU).

Taxonomy

Entoloma liaoningense Yu Li, L.L. Qi & Xiao Lan He, **sp. nov.** FIGS 1–2

MycoBank MB 564420

Differs from *Entoloma sericeum* by its smaller basidiomata, its bisporic basidia, and its habitat.

TYPE: China. Liaoning Province, Benxi, Laotudingzi National Nature Reserve, 12 September 2010, Qi Liang-Liang 5589 (HMJAU 23636, **Holotype**).

ETYMOLOGY: *liaoningense* refers to Liaoning province, the collection location of the holotype.

BASIDIOMATA mycenoid to marasmioid. PILEUS 10–15 mm broad, plano-convex to hemispherical, slightly depressed at center, usually with a small papilla in the depression, more applanate to umbilicate in older ones, smooth, radially sulcate almost to the center, yellowish grey to pale brownish grey (3A2–3B2, 5B3), paler towards margin, slightly darker in the grooves, somewhat pale brown at the disc, dry, hygrophanous, sometimes zonate with one or two zones when mature. LAMELLAE sinuate to adnate, with short decurrent tooth, ventricose, moderately distant, thin, 1–3 mm broad, whitish grey, becoming somewhat pale pinkish with age, with concolorous and somewhat eroded edge; with lamellulae in two tiers. STIPE central, 35–45 × 1–2.5 mm, cylindrical, equal, pale brown, concolorous with the pileus center, hollow, glabrous, smooth, polished, dry, often with white tomentum at base. CONTEXT greyish white, very thin. ODOR and TASTE not distinctive.

BASIDIOSPORES 8.0–10.5 × 7.0–8.5 μm, 5–6-angled in side-view, Q=1.0–1.25 (Q_m=1.15±0.03), isodiametric to subisodiametric, thick-walled. BASIDIA clavate, 25–37 × 8–12 μm, 2-spored, sometimes 1-spored; base clampless. LAMELLA EDGE fertile. CHEILOCYSTIDIA and PLEUROCYSTIDIA absent. LAMELLA TRAMA subparallel, composed of cylindrical, 8–18 μm wide, slightly encrusted elements. PILEIPELLIS a cutis of repent hyphae; terminal elements cylindrical to narrowly clavate, 5–11 μm in diam, with pale brownish internally encrusting and intracellular pigment; subpellis composed of yellow brown, cylindrical elements, 6–13 μm in diam. STIPITIPELLIS a cutis of cylindrical hyphae, 5–15

Fig. 1. *Entoloma liaoningense* (holotype HMJAU 23636): basidiomata.

μm wide, with pale brown, intracellular and encrusting pigment. Brilliant granules absent. Oleiferous hyphae rare. Clamp connections absent in all tissues.

Habitat: Scattered or solitary on soil among pine needles in mixed forests with *Pinus koraiensis* and *Quercus mongolica* or in coniferous forests with *Pinus koraiensis*.

Additional specimens examined: **China. Liaoning Province**, Benxi, Laotudingzi National Nature Reserve, 13 September 2010, Qi Liang-Liang 5659 (HMJAU 23637); 14 September 2010, Qi Liang-Liang 6076 (HMJAU 23638); Qi Liang-Liang 6144 (HMJAU 23639); Qi Liang-Liang 6176 (HMJAU 23640).

Commentary: The combination of characters such as the mycenoid to marasmioid habit, radially sulcate and pale brownish pileus surface, bisporic basidia, and isodiametric to subisodiametric basidiospores is diagnostic for *E. liaoningense*. Its mycenoid habit, absence of clamp-connections, and basidiospores that are never cuboid or cruciform, place it in subg. *Nolanea,* where it may be placed in sect. *Papillata* based on the absence of cystidia and presence of both incrusting and intracellular pigments.

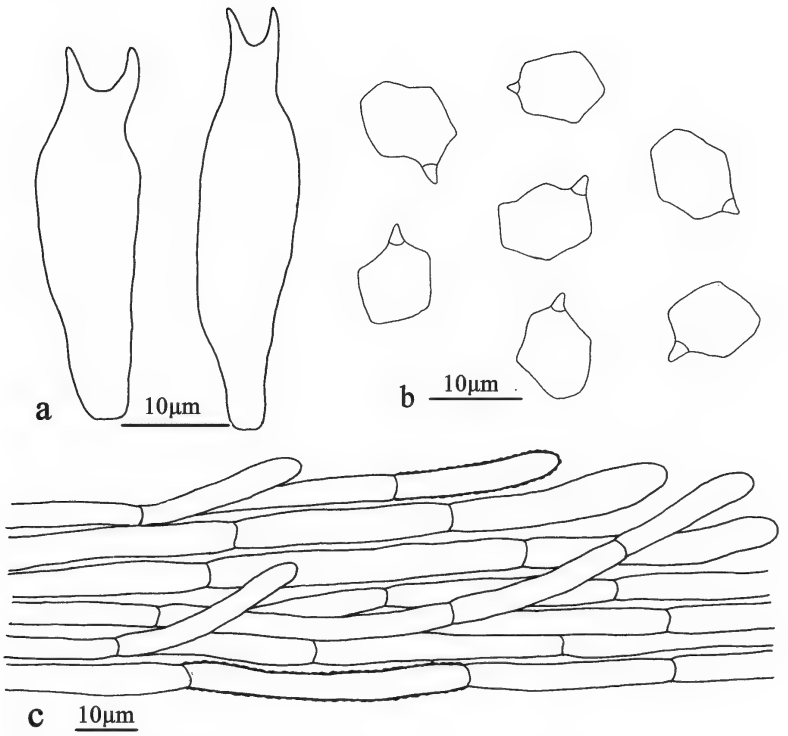

FIG. 2. *Entoloma liaoningense* (holotype): a. Basidia; b. Basidiospores; c. Pileipellis.

The basidioma stature, the pale brownish grey pileus, and the 2-spored basidia reminds one of the Japanese species *Entoloma bisporum* (Hongo) Hongo (Hongo 1957, as *Rhodophyllus bisporus*). However, *E. bisporum* can be easily distinguished by the more heterodiametric (8.5–9.5(–10) × (5.5–)6–6.5(–7) μm) basidiospores. In addition, the ecology of the two species also differs, with *E. bisporum* always occurring among mosses, while *E. liaoningense* is found on soil among pine needles.

Two other bisporic species described recently from China — *E. mastoideum* T.H. Li & Xiao Lan He and *E. praegracile* Xiao Lan He & T.H. Li (He et al. 2011) — also differ from *E. liaoningense*. *Entoloma mastoideum* can be easily distinguished by the pinkish to flesh-colored pileus, cylindrical to narrowly clavate cheilocystidia, and larger basidiospores (9.5–12(–13) × 7–8(–8.8) μm). *Entoloma praegracile* can be differentiated by the wax-yellowish to pale orange-yellow pileus and stipe and the heterodiametric basidiospores ((8–)9–10.5 × 6.5–8(–8.5) μm). The European *E. bisporigerum* (P.D. Orton) Noordel.

also has a brownish pileus and bisporic basidia but is separated by the larger basidiospores (10–12(–13) × (7.0–)8.0–9.5(–10.5) μm) and the presence of abundant clamp connections in all tissues (Noordeloos 1992).

The macro- and microscopic characters of *E. liaoningense* are somewhat similar to those of *E. sericeum* Quél.; nevertheless, *E. sericeum* can be separated by larger basidiomata (pileus 2–7 cm broad), tetrasporic basidia, and occurrence in grasslands or meadows (Noordeloos 1992).

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Beauveria lii sp. nov. isolated from *Henosepilachna vigintioctopunctata*

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Abstract — This paper describes a previously unreported entomopathogenic *Beauveria* species isolated from a lady beetle larva collected in Xunyi County, Shaanxi Province, China, in September 2010. Its main distinguishing morphological feature is its ellipsoidal to cylindrical conidia that are larger than those of other *Beauveria* species with cylindrical conidia. Phylogenetic analysis of four nuclear loci uniquely differentiate it from known *Beauveria* species that also produce cylindrical conidia, but place it with *B. varroae* and *B. kipukae*, two cryptic species that constitute the sister lineage to *B. bassiana* sensu stricto, additionally supporting its proposed species status. Integration of morphological and molecular evidence support classification of this unknown organism as a new species, here named *Beauveria lii*.

Key words — entomogenous fungi, taxonomy, multilocus phylogeny

Introduction

Beauveria Vuill. is one of the most ubiquitous anamorphic genera of entomopathogenic fungi. The genus is characterized morphologically by sympodial conidiogenous cells and sporulation on an indeterminate, denticulate rachis. Because the broad overlap in conidial dimensions and shape made it difficult to differentiate species, MacLeod's (1954) broad-sense species, *B. bassiana* (Bals.-Criv.) Vuill. and *B. tenella* (Sacc.) Siemaszko (= *B. brongniartii* (Sacc.) Petch), were used for more than 50 years until molecular evidence demonstrated that these were complex species consisting of morphologically similar but cryptic lineages (Rehner & Buckley 2005, Rehner et al. 2011). Evidence for cryptic diversification was first inferred from the nuclear ribosomal internal transcribed spacer (ITS) and elongation factor 1-alpha (EF1-α) (Rehner & Buckley 2005). Rehner et al. (2011) proposed a multilocus phylogeny of *Beauveria* species based on partial sequences of RNA polymerase II largest subunit (RPB1), RNA polymerase II second largest subunit (RPB2), translation elongation factor-1 alpha (TEF), and the Bloc nuclear intergenic

region. They established a new classification system that distinguished 12 species, six of which produce ellipsoidal or cylindrical conidia (i.e., *B. amorpha* (Höhn.) Samson & H.C. Evans, *B. malawiensis* S.A. Rehner & Aquino de Muro, *B. caledonica* Bissett & Widden, *B. brongniartii*, *B. asiatica* S.A. Rehner & Humber, *B. sungii* S.A. Rehner & Humber; Samson & Evans 1982, Bissett & Widden 1988, Rehner et al. 2006, Shimazu et al. 1988, Rehner et al. 2011). Five other species producing globose to subglobose conidia are *B. bassiana*, *B. australis* S.A. Rehner & Humber, *B. kipukae* S.A. Rehner & Humber, *B. pseudobassiana* S.A. Rehner & Humber, and *B. varroae* S.A. Rehner & Humber (Rehner et al. 2011). In addition, *B. vermiconia* de Hoog & V. Rao (de Hoog & Rao 1975) produces comma-shaped conidia. The species position of *B. sobolifera* Zuo Y. Liu et al. (Liu et al. 2001), anamorph of *Cordyceps sobolifera* (Hill ex Watson) Berk. & Broome, has yet to be verified by the multilocus method.

A fungal epizootic was observed in a population of the lady beetle *Henosepilachna vigintioctopunctata* in Shaanxi, China, caused by a *Beauveria* species. Although this organism formed colonies that were similar to those of *B. bassiana*, it had a unique microscopic morphology that differs from *B. bassiana* and other species. In this study, we investigate the morphological characteristics and molecular evidence to determine whether this organism is a novel species.

Materials & methods

Fungal culture

20 *Beauveria* strains were isolated from specimens of the lady beetle species *Henosepilachna vigintioctopunctata* (*Coleoptera*, *Coccinellidae*), collected in Shaanxi, China. RCEF5500 was selected as a test subject from these isolates. Routine growth was tested on full strength Sabouraud's dextrose agar. This isolate was incubated at 25°C under 12:12 hour light-dark fluorescent illumination.

Colony growth and morphology

Colony description and measurement were determined on the 10th day of culturing. Terms and notations used to describe colony coloration followed those of Kornerup & Wanscher (1961). Microscopic measurements of conidiogenous cells and conidia were taken from slide cultures on the 4–6th day. Images were acquired with a DP70 digital camera mounted on an Olympus BX51 microscope, with DP-BSW software (Olympus, Tokyo, Japan). Mean values for length, width, and length to width ratio (Q) are indicated by L^m, W^m, and Q^m.

DNA extraction, PCR, cloning, sequencing, and analysis

Conidia were inoculated on potato dextrose agar (PDA) Petri plates-overlaid with a disc of sterilized cellophane, and incubated at 25°C for 5 days. Fungal mycelia were obtained by scraping the cellophane. DNA extraction was performed using benzyl chloride to disintegrate the cell wall chemically as in previously described methods (Zhu et al. 1994, Wang et al. 2005). The concentration and quality of the purified DNA was evaluated by 0.8% agarose gel electrophoresis and spectrophotometry. The extracted

DNA was added to sterile distilled water at a final concentration of 100 ng per μL and stored at –20°C for the following PCR reactions.

Nuclear ribosomal internal transcribed spacer region (ITS) was amplified by PCR as described by White et al. (1990). For phylogenetic analysis of the isolated *Beauveria* strains (Rehner et al. 2011), the partial sequences of four nuclear loci (TEF, Bloc, RPB1, and RPB2) were amplified as described by Rehner & Buckley (2005), Rehner et al. (2011). PCR products were purified with the AxyPrep DNA gel purification kit (Axygene Biotechnology Hangzhou, Hangzhou, China) and were cloned using the PMD18-T plasmid vector (TaKaRa Dalian Corporation, Dalian, China).

The DNA samples were sequenced by Invitrogen Company (Shanghai, China). The derived ITS, TEF, Bloc, RBP1, and RBP2 sequences of RCEF5500 were submitted to GenBank.

Sequence alignment and phylogenetic analyses

TEF, Bloc, RBP1, and RBP2 sequences from 68 taxa determined by Rehner et al. (2011) (including 67 *Beauveria* isolates and one *Isaria tenuipes* Peck strain, which was used as the outgroup) were downloaded from GenBank. Multiple sequence alignments of these loci for the 68 isolates and from the isolate RCEF5500 was carried out by the software Bioedit (Hall 1999). Editing of sequences was performed with Bioedit, according to Rehner et al. (2011). The sequence files of the above four genes were concatenated manually into a single file and submitted to European Molecular Biology Laboratory-European Bioinformatics Institute for multiple alignment using fast Fourier transform (http://www.ebi.ac.uk/Tools/msa/mafft/). The resulting output was in Nexus file format to permit phylogenetic analysis by Molecular Evolutionary Genetics Analysis 4.0 (Tamura et al. 2007). The dataset was analyzed using both maximum parsimony and Bayesian approaches.

The combined data set of the four genes was analyzed phylogenetically using PAUP* 4.0b10 (Swofford 2003) under maximum parsimony, employing a heuristic search with 100 random addition replicates, tree bisection-reconnection (TBR) branch swapping, and saving multiple trees. Branch support was estimated by performing 1000 bootstrap replicates, with a full heuristic search (Felsenstein 1985). Clades with bootstrap values ≥70% were considered robustly supported by the data and are listed above branches in the *Beauveria* phylogenetic tree (Fig. 1).

A Bayesian analysis was carried out in MrBayes 3.1.2 (Huelsenbeck et al. 2001) applying a general time reversible model and gamma-distributed rate variation to account for rates of variation across sites, with a proportion of them being invariant sites. The remaining parameters were default values. One tree was saved to a file every 1000 generations for a total of 1,000,000 Markov Chain Monte Carlo (MCMC) generations; the first 25% of trees were discarded as burn-in. Values of the posterior probabilities for the branches supported by ≥95% of pseudo-replicates were listed below branches in the phylogenetic tree.

Results

The derived ITS, TEF, Bloc, RBP1, and RBP2 sequences of RCEF5500 were accepted by GenBank with accession numbers of JN689372, JN689371, JN689373, JN689374, and JN689370, respectively.

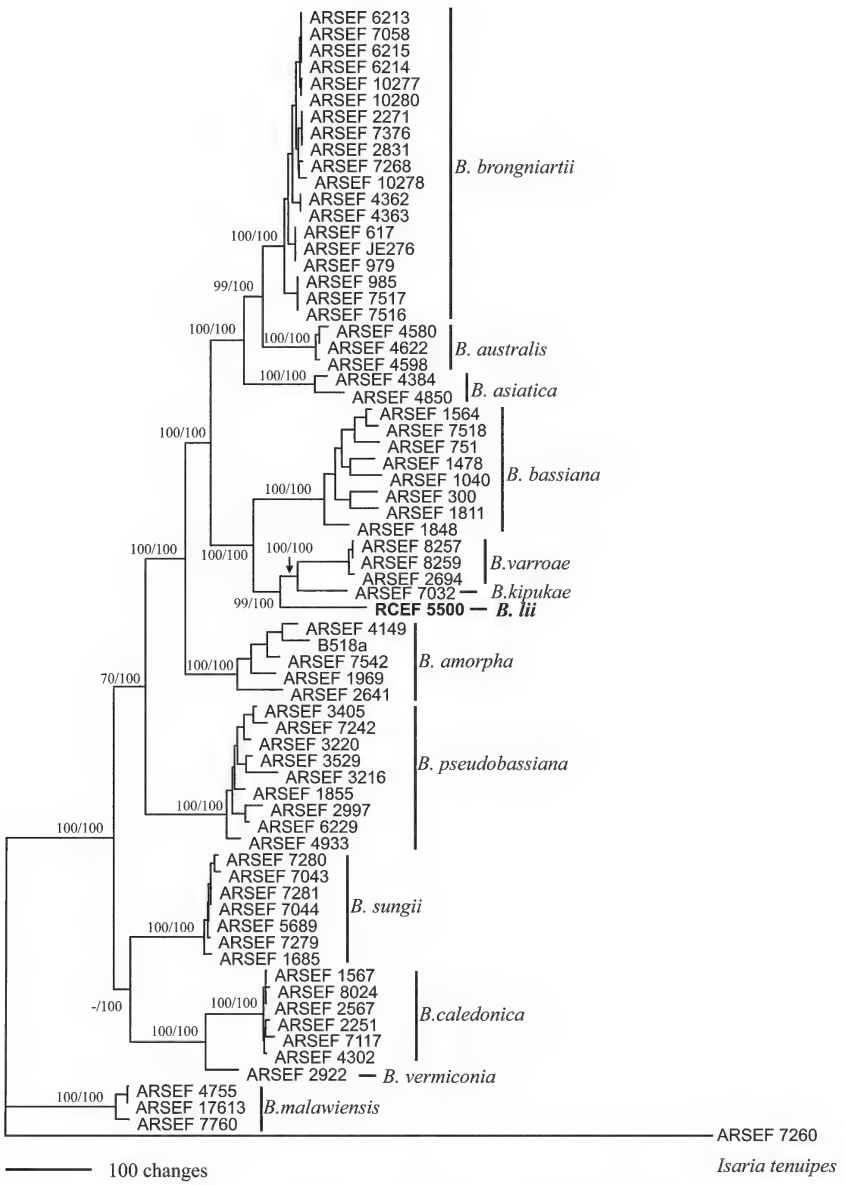

FIG. 1. Phylogenetic tree of *Beauveria* based on maximum parsimony and Bayesian analysis of the combined Bloc, TEF, RPB1, and RPB2 dataset. Bootstrap values (≥70%) and Bayesian posterior probabilities (≥95%) are labeled above and below branches, respectively. Sequence data from all strains except RCEF5500 are from Rehner et al. (2011). RCEF5500 is indicated in boldface.

The ITS sequence of RCEF5500 differed from other *Beauveria* species. Online BLAST searches of the National Center for Biotechnology Information databases showed that the RCEF5500 isolates are most similar to *B. varroae* (ARSEF 8257, HQ880800, 98%), *B. kipukae* (ARSEF 7032, HQ880734, 97%), and *B. bassiana* (ARSEF 1564, HQ880761, 97%), making it hard to determine the species position. Further comparative multilocus analysis was undertaken to determine its taxonomic and phylogenetic status.

The combined four-gene, 69 taxon data set published by Rehner et al. (2011) included 7750 bp of sequence data (Bloc: 1645; TEF: 1010; RPB1: 2928; RPB2: 2167). After excluding ambiguously aligned regions, the final alignment comprised 7569 bp (Bloc: 1558; TEF: 986; RPB1: 2861; RPB2: 2164), of which 1261 were parsimony informative. The sequence alignments are available from TreeBASE as submission 11144. The bootstrap values from maximum parsimony analyses and the posterior probability values from one of the Bayesian analyses are shown in Fig.1.

Phylogenetic analysis with four nuclear loci supports RCEF5500 as closely related to two species, *B. varroae* and *B. kipukae* but in an independent lineage (Fig. 1). Morphologically, RCEF5500 is easily distinguishable from these two species by its large, ellipsoidal to cylindrical conidia. Additionally, the phylogenetic analysis showed that RCEF5500 and three morphologically similar species (*B. amorpha, B. caledonica, B. malawiensis*) all clustered separately into different clades and are clearly distinguishable from each other. Therefore, the phylogenetic data support the recognition of RCEF5500 as a distinct species.

Taxonomy

Beauveria lii Sheng L. Zhang & B. Huang, **sp. nov.** Plates 2–11

MycoBank MB563695

Differs from all other *Beauveria* species by its larger ellispoidal to cylindrical conidia, with a larger mean length/width ratio.

Type: China, Shaanxi Province, Xunyi County, isolated from a larva of *Henosepilachna vigintioctopunctata*, 23 Sep 2010, coll. Ling-ming He (**Holotype**, RCEF5500; GenBank JN689370–689374). A living ex-type culture ARSEF 11741 is deposited in USDA-ARS Collection of Entomopathogenic Fungal Cultures (Ithaca, NY).

Etymology: *lii* is named in honor of Zengzhi Li, in recognition of his contributions to the study of entomopathogenic fungi, especially *B. bassiana*.

Colony growth and appearance similar on full strength Sabouraud's dextrose and potato dextrose agars, 28–29 mm in diam. after 10 d at 25°C, non-odorous, cottony, powdery while sporulating; white to cream, with a white margin. Reverse colorless, sometimes pale yellow in older portions. On Czapek-Dox agar, colonies slow growing, 19 mm in diameter, thin, sparse, with reverse colorless; sporulating poorly. Vegetative hyphae septate, branched, hyaline, smooth walled, 1.3–3.4 µm wide. Conidiogenous cells solitary but occasionally

occurring in tight clusters of two to three, the base ellipsoidal to cylindrical 4.8–9.0 × 1.7–2.6 µm (Figs 2, 4, 7), or sometimes globose to subglobose (Figs 5, 6) and produced laterally on aerial hyphae or from subtending cells mostly 4.8–9.0 × 1.7–2.6 µm (Figs 3, 10) Conidiogenous cell apex with an indeterminate, geniculate, denticulate rachis less than 1µm wide. Conidia (3.1–)4.3–6.5(–10.1) × (1.4–)2.1–2.6(–3.6) µm, Q = 2.1–2.7 (L^m = 5.2 µm, W^m = 2.3 µm, Q^m = 2.3), mostly ellipsoidal to cylindrical (Fig. 8), occasionally obovoid (Figs 6, 10) and very occasionally slightly flattened on one side, usually produced from conidiogenous cells but occasionally directly from hyphal tips or laterally from hyphae (Figs 9, 11). Teleomorph not observed.

Additional material examined: RCEF5183–5195, RCEF5887–5862.

Microscopically, *B. lii* is distinct from other *Beauveria* species mainly by its large ellipsoidal to cylindrical conidia. The six other *Beauveria* spp. with similarly shaped conidia all produce smaller conidia: *B. amorpha* (mean = 3.3 × 2.0 µm), *B. asiatica* (mean =3.2 × 2.3 µm), *B. brongniartii* (mean = 3.0 × 1.6 µm), *B. caledonica* (mean = 3.6 × 1.8 µm), *B. malawiensis* (mean = 3.9 × 1.9 µm), *B. sungii* (mean = 3.0 × 2.1 µm); the mean conidial length/width ratios (Q^m) of these six species are also smaller (ranging from 1.4 to 2.1; Rehner et al. 2011, Humber & Rehner 2007) than that of *B. lii,* which has the largest Q^m in the genus.

Discussion

In addition to the cryptic species within the *B. bassiana* sensu lato and *B. brongniartii* sensu lato, additional new species (e.g., *B. asiatica*, *B. australis*, *B. kipukae*, *B. pseudobassiana*, *B. sungii, B. varroae*) have been differentiated chiefly on the strength of molecular data. However, morphological identification of these species remains difficult in the absence of molecular data. For example, morphological overlap makes difficult the physical differentiation among *B. bassiana, B. pseudobassiana*, *B. australis*, *B. kipukae*, and *B. varroae*. The multilocus phylogeny approach should be applied to identification of both cryptic and unknown species of *Beauveria*. This study has demonstrated that the four-locus phylogenetic method of Rehner et al. (2011) can be used to provide a practical solution for distinguishing complex species and establishing a taxonomic and systematic position for an unknown species, such as *B. lii*.

China is a country rich in fungal species diversity; various *Beauveria* species have been recorded in different geographical locations, including the dry northwest region. *Beauveria lii* was discovered in such an area, suggesting that this vast zone should be further investigated for entomopathogenic fungi.

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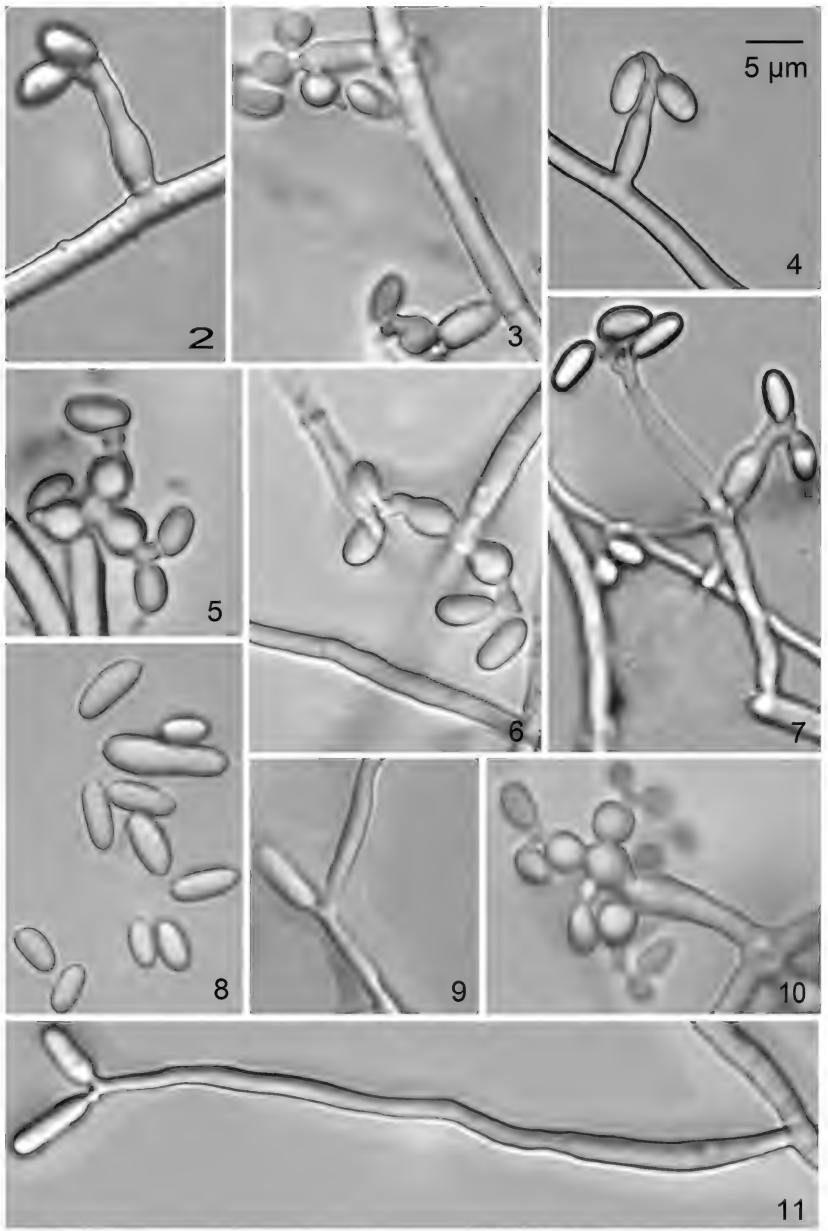

Figs 2–11. *Beauveria lii* (holotype, RCEF5500). 2, 4, 7. Ellipsoidal or cylindrical conidiogenous cells. 3, 10. Globose conidiogenous cell originating from subtending cells. 5–6. Globose conidiogenous cell. 8. Conidia. 9. Conidia originating from mycelium directly. 11. Conidia forming from a hyphal tip. Bar = 5 µm.

identification. This work was supported by a grant from the Natural Science Foundation of China (Nos. 30972368 and 31070009).

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Kuehneola warburgiana comb. nov. (*Phragmidiaceae, Pucciniales*), causing witches' brooms on *Rosa bracteata*

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Abstract—Caeomatoid rust infection has been observed on *Rosa bracteata* plants at a single site in Ishigaki Island, Okinawa, Japan, since 1995. The fungus (not previously known in Japan) was identified as *Caeoma warburgiana* by its characteristic systemic infection causing witches' brooms and its spore morphology. Uredinial and telial sori were found on the leaves of the witches' brooms of the infected rose plants at the same site in 2009. The urediniospores were pedicellate and echinulate. The teliospores were composed of two to four linearly arranged, thin-walled cells on a short pedicel. *Caeoma*-type aecia, *Uredo*-type uredinia and pedicellate teliospores with two to four linearly arranged cells are characteristic of the genus *Kuehneola*. Identical telia and teliospores were found in the lectotype of *C. warburgiana*. *Caeoma warburgiana* is recombined as *Kuehneola warburgiana*.

Key words —Asia, life cycle, nomenclature, taxonomy

Introduction

Rosa bracteata is an evergreen perennial shrub, native of southern regions of China, growing in mixed forests, scrub, and sandy hills at low altitudes and seashores (Wu & Raven 2003). The plants also occur at coastal areas of Taiwan and adjacent islands of south Japan (Satake et al. 1989, Liu et al. 2000, Wu & Raven 2003). Although this rose, called "McCartney rose," has been introduced to the United States for breeding new cultivars like "Mermaid" (Beales et al. 1998), it has become a noxious weed in southern States (Texas Invasive Plant and Pest Council 2011).

In the native regions of this rose species, *Caeoma "rosae-bracteatae"*, *C. warburgiana*, and *Kuehneola japonica* have been reported to occur (Anonymous 1979; Hiratsuka & Chen 1991; Sawada 1943; Zhuang 1983); however, only the last fungus has previously been known in Japan (Hiratsuka et al. 1992, Kobayashi 2007). In December 1995, a caeomatoid rust infection was found on *R. bracteata* plants at a single site at Hirakubo Peninsula, Ishigaki Island, Okinawa. The caeomatoid fungus causing witches' brooms on roses was

previously not known in Japan. Through continued field observations, uredinial and telial sori were found on the leaves of the witches' brooms of the infected rose at the same site in February 2009.

This paper describes the morphology of the whole life cycle of the *R. bracteata* rust fungus and discusses its taxonomic relationships to *C.* "*rosae-bracteatae*."

Materials & methods

Small sorus-bearing pieces were cut out from the herbarium specimens and thin-sectioned with a razor blade under a binocular dissecting microscope. Spores and paraphyses were scraped from sori. Thin-sections, scraped spores, and paraphyses were mounted on microscopic slides and treated by the method described by Ono (2000). The slide preparations were then examined both by bright-field and differential interference contrast microscopy (DIC) with an Olympus BH2 microscope (Olympus, Tokyo, Japan), and measurements were made with an ocular micrometer. Fifty or twenty randomly selected spores and paraphyses were measured for each specimen and five or ten spermogonia were measured. For observation of urediniospore germ pores, spores were mounted in lactic acid on glass slides and heated to boiling point for a few seconds, after which a drop of lactophenol solution with aniline blue was added onto the boiled spores.

For scanning electron microscopy (SEM), spores scraped from herbarium specimens were placed on double-sided adhesive tape on a specimen holder and coated with platinum-palladium at 25 nm thicknesses under a Hitachi E-1030 ion sputter (Hitachi, Tokyo, Japan). Samples were observed with a Hitachi S-4200 SEM operating at 15 kV.

Taxonomy

Kuehneola warburgiana (Henn.) Y. Ono **comb. nov.** FIGS. 1–3

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≡ *Caeoma warburgiana* Henn., in Warburg, Monsunia 1: 4, 1899 ["1900"].

LECTOTYPE (**designated here**): on *Rosa* sp., China, Zhejian, Ningbo, 0 + I + III, Dec 1887, O. Warburg (B).

Caeoma "*rosae-bracteatae*" Sawada, Rep Dept Agr Gov Res Inst Formosa 86:131, 1943, nom. inval.

AECIAL INFECTION systemic, causing witches' brooms on shoots spreading a large area. SPERMOGONIA on juvenile shoot tips, leaf stipules and petioles (but not on leaf body), subepidermal, of determinate growth, dome-shaped or broadly convex with flat hymenium, 139–206 µm wide, and 58–104 µm high. AECIA strictly on shoots, subepidermal in origin becoming erumpent, of indeterminate growth, neither peridiate nor paraphysate, bright orange-colored, and powdery. AECIOSPORES formed in basipetal succession, but separated soon after maturation, thus not forming chains; ellipsoid to broadly ellipsoid, often angular, and 20–29 × 12–18 µm in size; wall 1–2 µm thick at sides, apically thickened, colorless, and verrucose with no apparent germ pore.

FIGURE 1 *Kuehneola warburgiana* (IBAR-7744). A. Witches' brooms exhibited by *Rosa bracteata* shoots with spermogonial/aecial infection. B. Early stage of witches' broom development. Leaf petioles and stipules are densely covered with orange-colored spermogonia. C. Mature caeomatoid aecia on shoots with powdery orange-colored spores. D. Vertical section of a subepidermal spermogonium with a flat hymenium. E. Vertical section of caeomatoid aecium. Aeciospores are formed in basipetal succession. F. Aeciospores. G. Surface structure of an aeciospore. Bars: D = 50 μm; E, F = 10 μm; G = 5μm

UREDINIA on abaxial leaf surface, scattered or in loose groups, bright orange-colored and powdery, subepidermal in origin and erumpent, peripherally paraphysate, and often mixed with teliospores; paraphyses irregularly cylindrical, weakly to strongly incurved, apically and dorsally thick-walled, colorless, 25–30 μm high, and 6–9 μm wide. UREDINIOSPORES formed singly on a short pedicel, ellipsoid, broadly ellipsoid, obovoid or pyriform, and 18–25 × 11–16 μm in size; wall thin, colorless, and echinulate with no apparent germ pore.

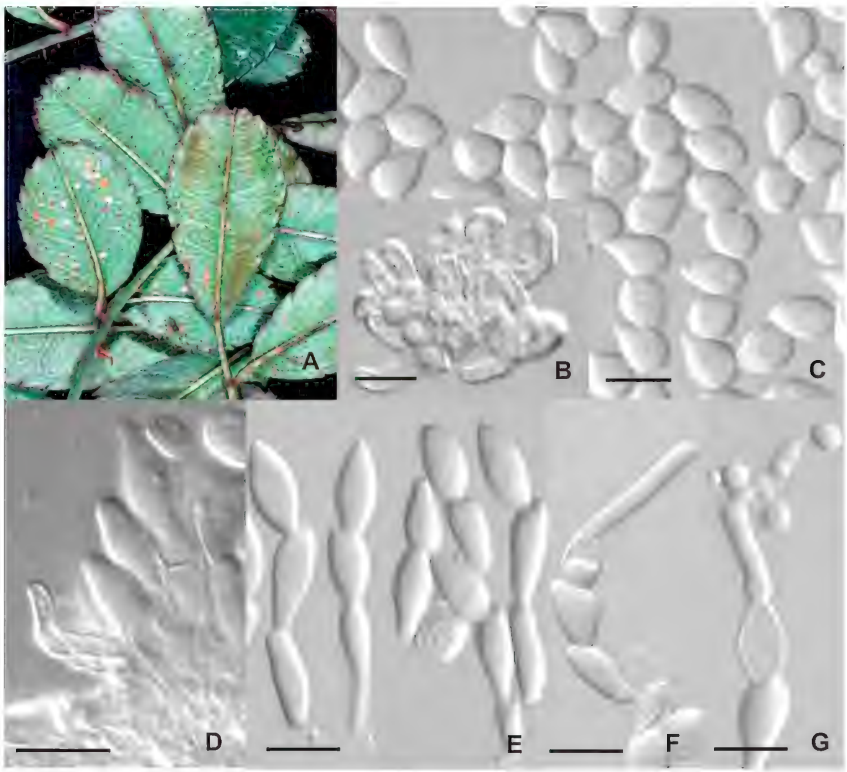

FIGURE 2 *Kuehneola warburgiana* (IBAR-10130). A. Orange-colored, powdery uredinia and white cottony telia formed on the abaxial leaf surface of *Rosa bracteata*. B. Incurved paraphyses. C. Urediniospores. D. Vertical section of a telium. The sorus is surrounded by incurved paraphyses. The wall is dorsally and apically thickened. E. Two- or three-celled teliospores with a short pedicel (fragment remained at the base). F. Metabasidium development from a distal end cell. G. Basidiospores formed from a four-celled metabasidium (one spore is missing). Bars = 20 μm

TELIA on abaxial leaf surface, white, cottony, peripherally paraphysate, and often intermixed with uredinia. TELIOSPORES composed of 2–4 linearly arranged cells formed on a short pedicel; each telial cell ovoid, ellipsoid or broadly ellipsoid, and 21–34 × 10–17 μm in size; wall thin and colorless; germinating in situ to form four basidiospores on a four-celled metabasidium.

ADDITIONAL SPECIMENS EXAMINED: On ***Rosa* sp.**: **CHINA, FUJIAN**, Futschau, Yuenfuthal, 0 + I, Dec. 1887, O. Warburg (B).

On ***Rosa bracteata*** J.C. Wendl.: **JAPAN, OKINAWA**, Ishigaki, Hirakubo Peninsula, 0 + I, 10 Dec 1995, Y. Ono (IBAR-7744); 0 + I, 7 Nov 1997, Y. Ono (IBAR-7961); 0 + I, 10 Nov 2002, Y. Ono (IBAR-8888); 0 + I + II + III, 17 Feb 2009, Y. Ono (IBAR-10130)

ECOLOGY—The rust infected *R. bracteata* plants spread in the steep slope at the peninsula in Ishigaki. The habitat is heavily utilized for grazing and the

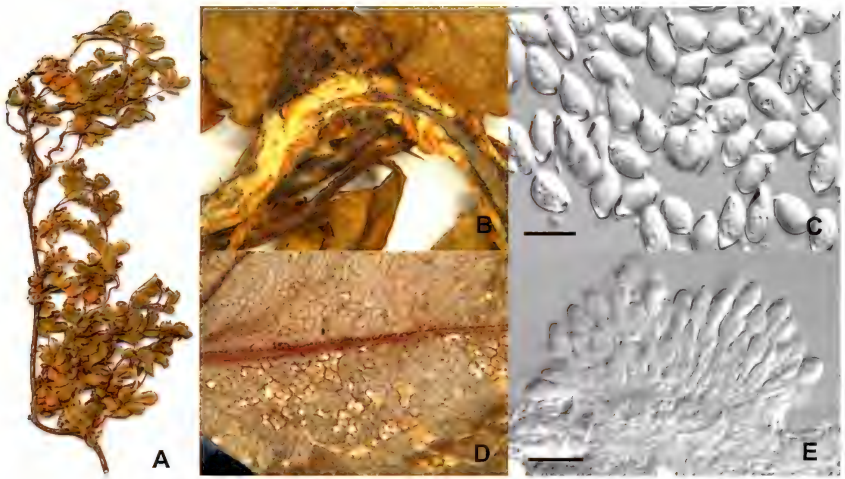

FIGURE 3 *Caeoma warburgiana* (Lectotype, deposited in B). A. Witches' brooms exhibited by unidentified rose shoots with spermogonial/aecial infection. B. Mature caeomatoid aecia with powdery spores. C. Aeciospores. D. White cottony telia formed on the abaxial leaf surface. E. Vertical section of a telium. Bars = 20 μm

prickly bushes are the property by which the rose is selected for in the habitat, otherwise it is not commonly observed in the island covered with subtropical evergreen forests.

COMMENTS—*Kuehneola japonica* (Dietel) Dietel is the only other *Kuehneola* species to occur on *Rosa* spp. This fungus is microcyclic and forms only telia on 15 species and 5 varieties of *Rosa,* being widely distributed in east and southeast Asia (Anonymous 1979; Arthur & Cummins 1936; Hiratsuka & Chen 1991; Hiratsuka et al. 1992; Kobayashi 2007; Sawada 1918, 1944; Teodoro 1937). This species forms pulvinate bright orange-colored telia, not associated with spermogonia, on both surfaces of leaves, petioles and shoots (Hiratsuka et al. 1992). The sori often become confluent, particularly along the leaf veins and on shoots; however, the telial infection is not systemic. Teliospores are 2–4-celled with a short, persistent pedicel. Each teliospore cell is 22–38 × 15–22 μm in size and thin-walled.

Phylogenetic relationships between *K. warburgiana* and *K. japonica* are not apparent. The non-systemic nature of telial infection of *K. japonica* suggests that the "correlated species" concept (Arthur 1934) and its evolutionary interpretation, Tranzschel's Law (Shattock & Preece 2000; Cummins & Hiratsuka 2003), may not apply to a possible relationship between the two fungi, i.e., a direct evolutionary derivation of microcyclic *K. japonica* from macrocyclic *K. warburgiana*.

In his protologue of *C. warburgiana,* Hennings (1899) cited two collections — "China, Fitschau und Ningpo: auf Zweigen von *Rosa* sp. Dez. 1887. (O. Warburg)." These collections are syntypes, because the protologue did not designate either as the holotype. In B, the collection from Ningpo (Zhejiang) is labeled as "holotypus" and the collection from Fitschau (Fujian) as "isotypus." Yet Hein (1989) listed the Fitschau collection as the "holotypus" and did not mention the other collection. In the Ningpo collection, the telia and teliospores are present (Figs. 3 D,E) and morphologically the same as those found on the Ishigaki collection (IBAR-10130). Therefore, the Ningpo collection is designated here as the lectotype (although it is possible that this collection may already have been designated as lectotype, by a corrective interpretation of the misapplied term "holotypus" on the label of the B herbarium specimen).

Caeoma warburgiana has been reported on *R. bracteata* in Fujian (Zhuang 1983), *R. banksiae* W. T. Aiton var. *banksiae* in Yunnan (Tai 1979), *R. banksiae* var. *normalis* Regel in Yunnan (Tai 1979), *R. hugonis* Hemsl. in Fujian (Zhuang 1983), and *R. longicuspis* Bertol. in Yunnan (Tai 1979).

Caeoma "*rosae-bracteatae*" Sawada was published (without Latin diagnosis) for a fungus on *R. bracteata* var. *bracteata* (as *R. bracteata* "var. *typica*" Lindl.) (Sawada 1943). Four specimens were cited, all from Hsinchu, Taiwan. The sori were described as elongated up to 70 mm and becoming naked with orange-yellow spores; the spores were in chains of 3–4, ellipsoid, globoid or obovoid-ellipsoid, and 22–36 × 11–16 µm in size; the wall was densely verrucose, 2 µm thick and up to 7–8 µm apically. Although none of Sawada's collections were available for the study, all the details described for the fungus support its biological identity with *C. warburgiana.*

Spermogonia of *Kuehneola* species are characterized by their subcuticular origin with a flat hymenium and indeterminate growth (Type 11 of Cummins & Hiratsuka 2003). However, intraepidermally formed spermogonia of indeterminate growth was reported for *K. loeseneriana* (Henn.) H.S. Jacks. & Holw. (Hernández & Hennen 2003). *Kuehneola warburgiana* forms Type 6 spermogonia (subepidermal with a flat hymenium of determinate growth), a type previously known only in *Gymnoconia* (Hiratsuka & Hiratsuka 1980; Cummins & Hiratsuka 2003).

Acknowledgments

I would like to express my gratitude to Dr. Robert Vogt, curator, the Mycological Herbarium, Botanischer Garten und Botanisches Museum Berlin-Dahlem for the loan of the type material examined in this study and Dr. Burghard Hein at the same institution for providing me with the data of the Hennings' fungal collections at B. I also thank peer reviewers, Dr. Stephan Helfer, Royal Botanic Garden, Edinburgh and Dr. Anibal A. de Carvalho, Jr., Instituto de Pesquisas Jardim Botânico do Rio de Janeiro and editors, Dr. Shaun Pennycook and Dr. Lorelei Norvell, for their technical assistance.

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New records of smut fungi. 6

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Abstract — Five species of smut fungi, *Leucocintractia scleriae, Sporisorium caledonicum, Sporisorium paspali-thunbergii, Sporisorium ugandense,* and *Ustanciosporium scleriicola,* are recorded for the first time from the Democratic Republic of the Congo. *Cyperus distans* is a new host of *Cintractia limitata* in Africa. For *Entorrhiza casparyana* var. *tenuis* on *Juncus tenuis,* a new combination and status, *E. tenuis,* are proposed.

Key words — taxonomy, *Ustilaginomycetes*

Introduction

Vánky et al. (2011) published a checklist containing 427 species in 47 genera of smut fungi in Africa and adjacent islands. We add a further five species to the smut fungi known from the Democratic Republic of the Congo and report *Cyperus distans* as a new host of *Cintractia limitata* in Africa. A new combination and status, at the species level, are proposed for *Entorrhiza casparyana* var. *tenuis* on *Juncus tenuis.*

Material & methods

Dried specimens from the mycological collection of the National Botanical Garden of Belgium (BR) were examined under light (LM) and scanning electron (SEM) microscopes. For LM observations, spores were mounted in lactophenol solution on glass slides, gently heated to boiling point to rehydrate the spores, and then cooled. Spore measurements are given in the form: min–max [mean ± 1 standard deviation]. For SEM, spores were attached to specimen holders by double-sided adhesive tape and coated with gold with an ion sputter. The surface structure of spores was observed at 10 kV and photographed with a JEOL JSM-5510 scanning electron microscope.

The distribution of the smut fungi in Africa is given in accordance with Vánky et al. (2011) while the general distribution is after Vánky (2011).

New records for the Democratic Republic of the Congo

Leucocintractia scleriae (DC.) M. Piepenbr., Begerow & Oberw., Mycologia 91: 497, 1999. FIGS 1–2

SORI around all the peduncles of an inflorescence with rudimentary spikelets, more or less cylindrical, often curved, 5–25 × 2–3 mm wide, when young covered by a thick peridium, later becoming exposed; spore mass of the mature sori dark reddish brown, agglutinated, powdery on the surface. SPORES slightly flattened, in plane view orbicular, suborbicular or broadly elliptical, in plane view 13–16.5 × 11.5–15.5 (14.8 ± 0.7 × 13.4 ± 0.9) µm (n = 50), in side view 9.5–12 µm wide, reddish brown; wall 0.9–1.5 µm thick, in LM with connected warts, forming rows, irregular and incomplete reticulum-like ornaments, or parallel ridges (especially, in side view); in SEM with well developed ornamentation: in plane view of coarse, irregular, connected warts, forming short or long rows, or fusing into irregular meshes, in side view of connected warts forming irregular meshes (the interspaces often with single or connected warts) or uneven, more or less parallel ridges, often connected by lower, transverse rows.

SPECIMEN EXAMINED — On *Rhynchospora corymbosa* (L.) Britton: **DEMOCRATIC REPUBLIC OF THE CONGO, ORIENTALE PROVINCE,** Garamba National Park, near Bagbele, 03°40′ N, 29°00′ E, 24 April 1950, leg. A. Noirfalise, no. 199 (BR 49871,13).

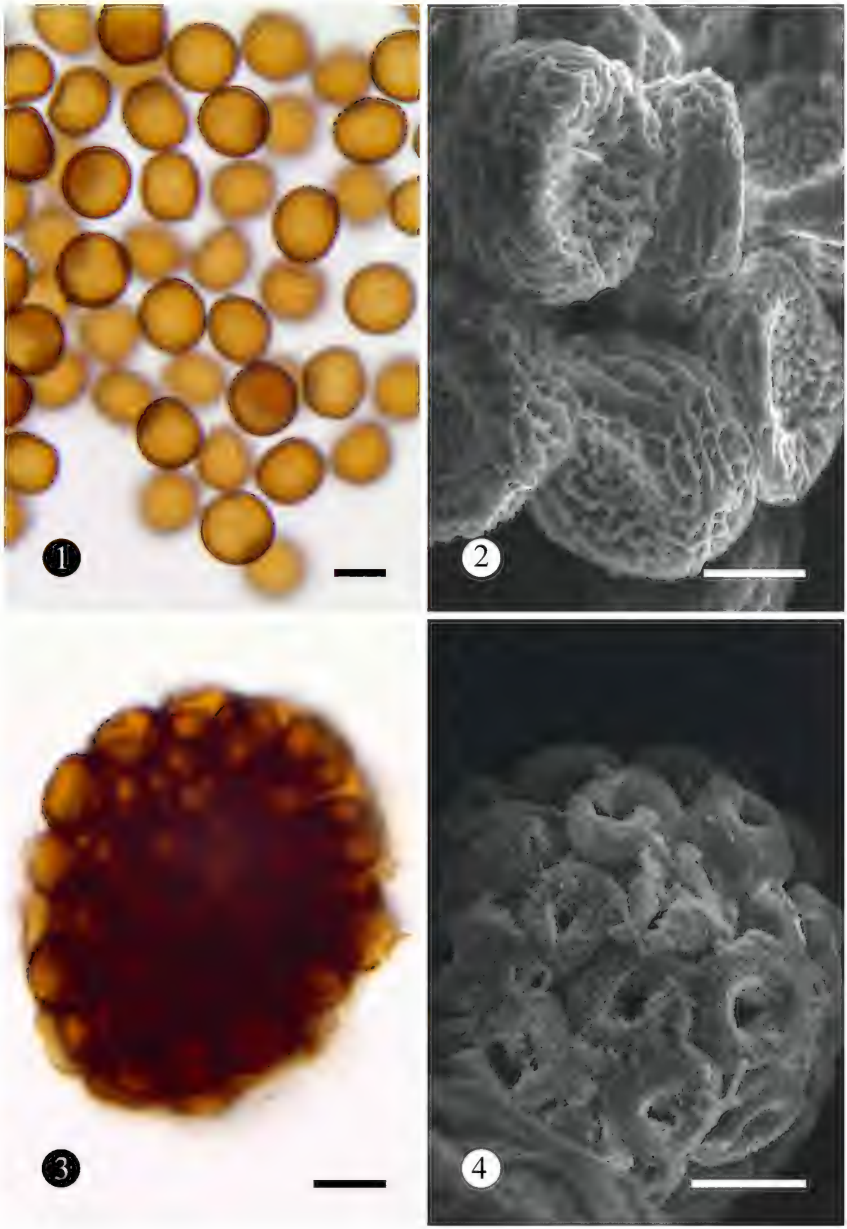
DISTRIBUTION — On *Rhynchospora* spp. (*Cyperaceae*), distributed in the tropics. In Africa known on *R. corymbosa* and *R. spectabilis* from Cameroon, Guinea, Namibia, Sierra Leone, South Africa, and Tanzania.

Sporisorium caledonicum (Pat.) Vánky, Mycotaxon 40: 165, 1991. FIGS 3–4

SORI destroying the whole inflorescence, when young covered by a greyish brown peridium, which ruptures irregularly exposing a dark reddish brown mass of permanent spore balls and several filiform columellae. SPORE BALLS irregular, broadly ellipsoidal, ellipsoidal or ovoid, 35–85 × 25–50 µm, dark reddish brown, often opaque, composed of tens, rather firmly united spores. STERILE CELLS absent. SPORES dimorphic. Outer spores subglobose, broadly ellipsoidal or slightly irregular, 9.5–13 × 7.5–11.5 (11.4 ± 0.9 × 9.5 ± 1.0) µm (n = 50), medium to dark reddish brown; wall 0.7–1.5 µm thick, in LM punctate to finely verruculose, spore profile slightly affected, in SEM punctate to finely verruculose.

SPECIMEN EXAMINED — On *Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.: **DEMOCRATIC REPUBLIC OF THE CONGO, KINSHASA PROVINCE,** Boma, 05°51′ S, 13°03′ E, 1921, leg. Claessens in Vanderyst, sine num. (BR 49827,66).

DISTRIBUTION — On *Heteropogon* spp. (*Poaceae*), Africa, South Asia, Australia, Papua New Guinea, North & South America. In Africa known on *H. contortus* from Ethiopia, South Africa, Zambia, and Zimbabwe.



Figs 1–2. ***Leucocintractia scleriae*** on *Rhynchospora corymbosa* (BR 49871,13). Spores in LM and SEM. Figs 3–4. ***Sporisorium caledonicum*** on *Heteropogon contortus* (BR 49827,66). Spore ball in LM and SEM. Scale bars: 1, 3, 4 = 10 μm, 2 = 5 μm.

Sporisorium paspali-thunbergii (Henn.) Vánky, Publications from the Herbarium *Ustilaginales* Vánky 3: 9, 1986. FIGS 5–6

SORI destroying the whole inflorescence, up to 10 cm long, 1–2.5 mm wide, partly hidden by the leaf sheath, when young covered by a thick, greyish brown peridium which ruptures irregularly exposing a powdery, dark reddish brown mass of spore balls and spores, and a long, filiform, central columella; the columella sometimes with short, lateral branches. SPORE BALLS broadly ellipsoidal, globose, ovoid or irregular, 35–70 × 30–55 µm, dark reddish brown, composed of eight to tens spores, separating easily. STERILE CELLS absent. SPORES irregular to subpolygonal, broadly ellipsoidal or subglobose, sometimes elongated, 11–17 × 9–13.5 (13.9 ± 1.3 × 11.6 ± 1.2) µm (n = 50), medium reddish brown; wall uneven, thicker at the angles, 0.7–2.0 µm thick, in LM punctate to verruculose on the free surface of the spores, and smooth on the contact surface, spore profile not affected, in SEM finely echinulate or verruculose.

SPECIMEN EXAMINED — On *Paspalum* sp.: **DEMOCRATIC REPUBLIC OF THE CONGO, ORIENTALE PROVINCE,** Kisangani, 00°31′ N, 25°11′ E, 19 January 1931, leg. R.L. Steyaert, no. 330 (BR 49888,30).

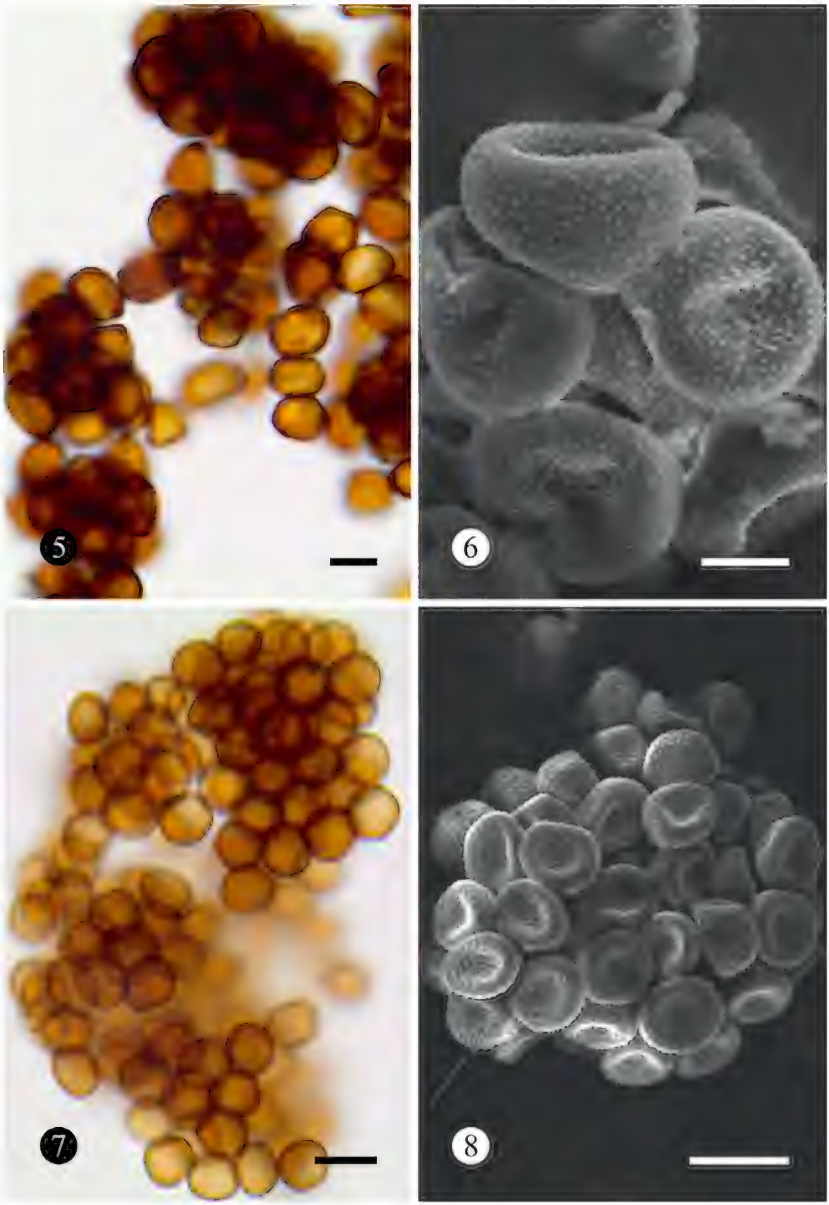
DISTRIBUTION — On *Paspalum* spp. (*Poaceae*), Africa, South and East Asia, Philippines, Australia, and Hawaii. In Africa known on *P. scrobiculatum* from Ethiopia, Malawi, South Africa, and Uganda.

Sporisorium ugandense (Henn.) Vánky, Mycotaxon 91: 250, 2005. FIGS 7–8

SORI destroying the distal part of sterile shoots, 4–6 cm long, 0.5–2 mm wide, partly hidden by the leaf sheath, covered by a greyish peridium which later ruptures, exposing powdery, dark brown mass of loose spore balls and spores, and numerous filiform columellae. SPORE BALLS globose, broadly ellipsoidal, ovoid or slightly irregular, 30–65 × 25–55 µm, medium reddish brown, composed of fifteen to tens spores, separating easily. STERILE CELLS absent. SPORES subglobose, broadly ellipsoidal, ellipsoidal, ovoid or slightly irregular, 7.5–12 × 7–9.5 (9.4 ± 0.8 × 8.1 ± 0.4) µm (n = 50), light reddish brown; wall 0.3–0.5 µm thick, in LM punctate to verruculose, spore profile not affected, in SEM verruculose.

SPECIMEN EXAMINED — On *Digitaria abyssinica* (A. Rich.) Stapf: **DEMOCRATIC REPUBLIC OF THE CONGO,** Tshirumbi, 02°19′ S, 28°47′ E, August 1945, leg. F.L. Hendrickx, no. 2882 (as *D. scalarum* (Schweinf.) Chiov., BR 49849,88).

DISTRIBUTION — On *Digitaria* spp. (*Poaceae*), Africa and Australia. In Africa known on *D. abyssinica* from Ethiopia, Kenya, and Uganda.



Figs 5–6. ***Sporisorium paspali-thunbergii*** on *Paspalum* sp. (BR 49888,30). Spore balls and spores in LM and SEM. Figs 7–8. ***Sporisorium ugandense*** on *Digitaria abyssinica* (BR 49849,88). Spore balls and spores in LM and SEM. Scale bars: 5, 7 = 10 μm, 6, 8 = 5 μm.

Ustanciosporium scleriicola (Cant.) M. Piepenbr., Nova Hedwigia 70: 352, 2000. FIGS 9–10

SORI in all flowers of the spikelets; spore mass of the mature sori black, powdery. SPORES single, flattened, in plane view orbicular, suborbicular, broadly elliptical or slightly irregular, in plane view 16.5–23 × 14.5–20.5 (18.9 ± 1.7 × 17.3 ± 1.4) µm (n = 50), in side view 9.5–13 µm wide, medium to dark reddish brown, no hyaline appendages; wall 1.0–1.9 µm thick, in LM foveolate-reticulate, the ornamentation slightly affecting the spore profile, in SEM foveolate or with reticulate pattern of low muri and irregular, polygonal meshes.

SPECIMEN EXAMINED — On *Scleria melanomphala* Kunth: **DEMOCRATIC REPUBLIC OF THE CONGO,** Katomia, Marungu, 07°20′ S, 29°40′ E, 28 April 1939, leg. Van den Brande, no. 120 (as *Ustilago* sp., BR 49895,37).

DISTRIBUTION — On *Scleria melanomphala, S. lagoensis* Boeckeler, *Scleria* sp. (*Cyperaceae*), Africa; known from Cameroon, Central African Republic, and Ethiopia.

A new host of *Cintractia limitata* in Africa

Cintractia limitata G.P. Clinton, Proc. Boston Soc. Nat. Hist. 31: 399, 1904. FIGS 11–12

SORI in individual flowers or groups of flowers; spore mass of the mature sori dark reddish brown, powdery. SPORES flattened, in plane view orbicular, suborbicular or broadly elliptical, sometimes slightly irregular, in plane view 9.5–13.5 × 7.5–12.5 (11.8 ± 1.0 × 10.5 ± 0.9) µm (n = 50), in side view 6.5–8.5 µm wide, light to medium reddish brown, wall 0.6–1.0 µm thick; in LM smooth, in SEM densely punctate of very low warts (often forming small groups or short rows).

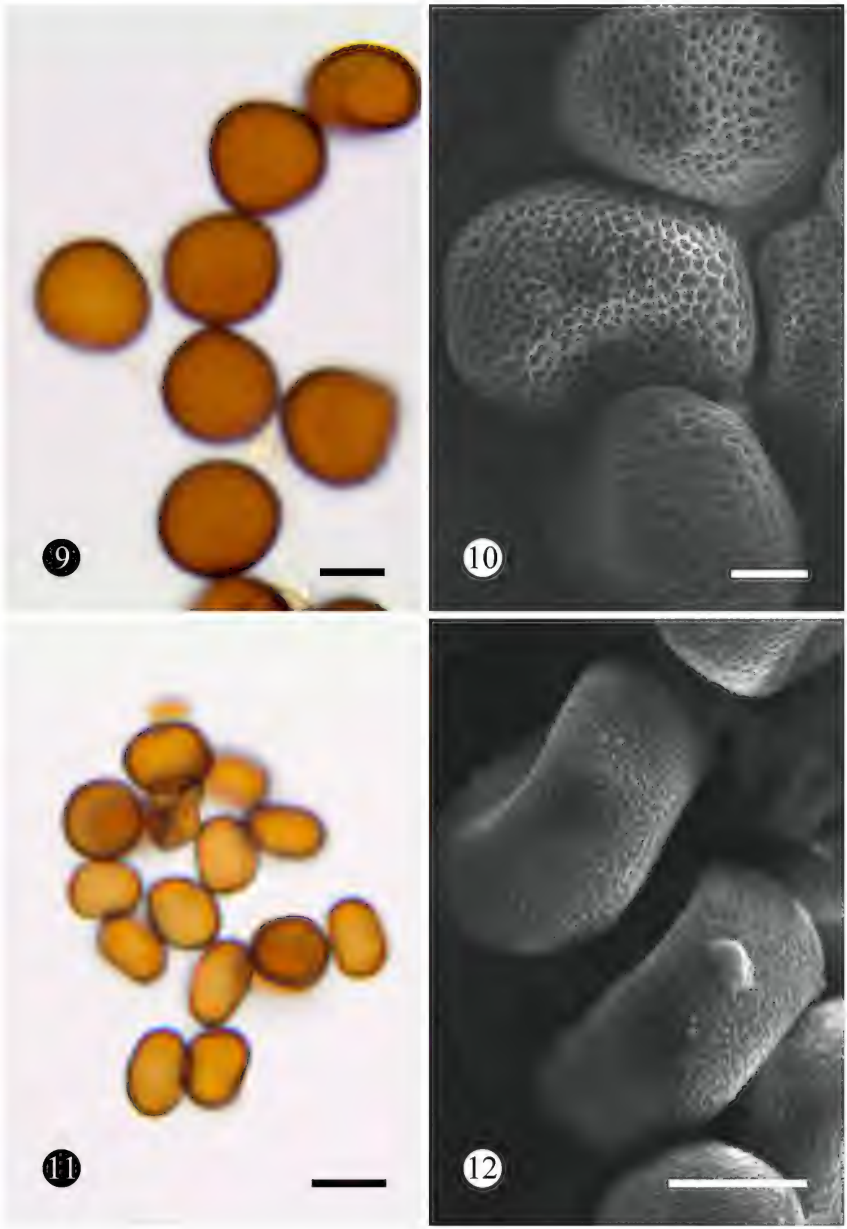
SPECIMEN EXAMINED — On *Cyperus distans* L.f.: **DEMOCRATIC REPUBLIC OF THE CONGO,** Equateur Province, Koli Koli, 00°05′ S, 18°12′ E, July 1930, leg. P. Staner, no. 213 (BR 49875,17).

DISTRIBUTION — On *Cyperus, Kyllinga,* and *Mariscus* spp. (*Cyperaceae*), tropics and subtropics. In Africa known from Cameroon, Congo, Ethiopia, Gabon, Ghana, Guinea, Ivory Coast, Malawi, Nigeria, Reunion, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. *Cyperus distans* is reported here as a new host of *Cintractia limitata* in Africa.

New combination and status of *Entorrhiza casparyana* var. *tenuis*

Entorrhiza casparyana (Magnus) Lagerh. var. *casparyana* attacks 17 species of *Juncus* (not including *J. tenuis*), and is distributed in Europe, North America, Africa, Australia, and New Zealand (Vánky & McKenzie 2002, Denchev & Minter 2008, Vánky & Shivas 2008, Denchev et al. 2011, Vánky et al. 2011).

Denchev et al. (2007) described a new variety of *Entorrhiza casparyana,* var. *tenuis,* restricted to one host, *Juncus tenuis,* and recorded only from South Korea, Austria, Romania, and Costa Rica (Vánky 1985, Piepenbring 2003,



Figs 9–10. ***Ustanciosporium scleriicola*** on *Scleria melanomphala* (BR 49895,37). Spores in LM and SEM. Figs 11–12. ***Cintractia limitata*** on *Cyperus distans* (BR 49875,17). Spores in LM and SEM. Scale bars: 9, 11 = 10 µm, 10, 12 = 5 µm.

Denchev 2004 [all as *E. casparyana*]; Denchev et al. 2007). It differs from var. *casparyana* especially by the shorter sori and spores. The sori of var. *casparyana* are up to 15 mm in length, whereas those of var. *tenuis* are only up to 5 mm long. The spores of var. *casparyana* are (12–)13.5–23(–32) µm long (including the ornamentations) while those of var. *tenuis* are 11.5–20(–21.5) µm long.

We suggest that *Entorrhiza casparyana* var. *tenuis* is morphologically distinct from *E. casparyana* var. *casparyana* and should be recognized at the species level.

Entorrhiza tenuis (Denchev & H.D. Shin) Denchev, Vánky & T. Denchev, **comb. et stat. nov.**

MycoBank MB 564487

≡ *Entorrhiza casparyana* var. *tenuis* Denchev & H.D. Shin, *Mycotaxon* 100: 74, 2007.

Type collections: on *Juncus tenuis* Willd., **KOREA, Gangwon Prov.**, near Hoengseong, 37°31′24.82″ N, 128°17′27.98″ E, 7 September 2006, C.M. Denchev (holotype, SOMF 26 206); 37°31′24.84″ N, 128°17′28.11″ E, 7 September 2006, C.M. Denchev (paratype, SOMF 26 207).

Illustrations: Denchev 2004: 50 (Figs 1–2, as *E. casparyana*), Denchev et al. 2007: 75 (Figs 1–2, as *E. casparyana* var. *tenuis*).

Comments — Four *Entorrhiza* species are known on *Juncus: E. aschersoniana* (Magnus) Lagerh. (Europe, Central America, New Zealand), *E. caricicola* Ferd. & Winge (Europe, New Zealand), *E. casparyana,* and *E. casparyanella* Vánky (New Zealand). *Entorrhiza tenuis* differs from *E. casparyanella* in having tuberculate or verrucose spore ornamentation with coarse tubercules or warts, whereas *E. casparyanella* spores have a smooth or undulate outer wall layer (cfr Vánky 1998: 342–343). Spore shape primarily distinguishes *E. aschersoniana* and *E. caricicola* from *E. tenuis,* with the mainly broadly ellipsoidal, ellipsoidal or ovoid (occasionally subglobose) spores with a length/width ratio >1.06 of the first two species contrasting with the globose or subglobose spores of *E. tenuis* (length/width ratio 1.04–1.05).

Key to *Entorrhiza* species on *Juncus*

1	Spores mainly broadly ellipsoidal, ellipsoidal or ovoid, occasionally subglobose, length/width ratio >1.06	2
1*	Spores globose or subglobose, length/width ratio ≤1.05	3
2	Spore wall rugulose-undulate or smooth	***E. caricicola***
2*	Spore wall verrucose	***E. aschersoniana***
3	Outer wall layer smooth or undulate; spores 10–17 µm long	***E. casparyanella***
3*	Outer wall layer coarsely tuberculate or verrucose, occasionally smooth	4
4	Spores (12–)13.5–23(–32) µm long, sori up to 15 mm long	***E. casparyana***
4*	Spores 11.5–20(–21.5) µm long, sori 1.2–5 mm long	***E. tenuis***

Acknowledgements

We gratefully acknowledge Dr Kálmán Vánky (Herbarium *Ustilaginales* Vánky, Tübingen, Germany) and Dr Roger G. Shivas (Biosecurity Queensland, Australia) for critically reading the manuscript and serving as pre-submission reviewers, and the Curator of the mycological collection of the National Botanical Garden of Belgium (BR) for the loan of the cited specimens.

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Suillus flavidus and its ectomycorrhizae with *Pinus wallichiana* in Pakistan

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Abstract — *Suillus flavidus* (*Boletales, Suillaceae*) was found associated with *Pinus wallichiana* during a survey of macrofungi from moist coniferous forests of Pakistan. Both the fruiting body and ectomycorrhizae were characterized morpho-anatomically as well as by molecular analysis. This fungus is a new record for Pakistan and its ectomycorrhizae with *Pinus wallichiana* are described for the first time by molecular analysis.

Key words —boletes, ITS, mantle, PCR, rDNA

Introduction

Coniferous forests of Pakistan are located at an elevation of 1373 to 3050 m a.s.l. and are characterized by luxuriant growth of trees such as *Abies pindrow*, *Cedrus deodara*, *Picea smithiana*, *Pinus roxburghii*, *P. wallichiana*, and *Taxus wallichiana.* Among these conifers, some deciduous trees and shrubs of different species also occur (Hussain 1995). Another important feature of these forests is the high level of rainfall during summer (July–August). High rainfall and temperature make an environment suitable for the growth of mushrooms. Most of these fungi form mutualistic symbiotic associations with forest trees in the form of ectomycorrhizae that facilitate tree growth through enhanced nutrient absorption and protection of roots from root pathogens (Marx 1991).

Suillus Gray, a genus with approximately 50 species (Kirk et al. 2008), is characterized by growth under conifers, slimy caps, glandular dots on the stipe, large pore openings that are often arranged radially, and a partial veil that leaves a ring around the stipe or tissue hanging from the cap margin (Kuo 2004). Nine *Suillus* species have been reported from Pakistan (Ahmad et al. 1997; Razaq 2007; Niazi 2008) associated with different conifers.

During field surveys of Pakistan forests, we collected *Suillus* mushrooms under pine trees in order to explore some new and noteworthy species of this

genus. The aim of the present work is to describe the morpho-anatomical features of the *Suillus* collections and their ectomycorrhizae with *Pinus wallichiana* as well as to confirm their identification by molecular analysis.

Materials & methods

The sampling was carried out in coniferous forests of Pakistan located at an elevation of around 2200 m during the 2010 rainy season (July–August). The sporocarps and blocks of soil exactly beneath the fruiting bodies were taken from the rhizosphere of *Pinus wallichiana*. The sporocarps were air dried while the soil blocks containing ectomycorrhizae (ECM) were wrapped in polythene bags and brought to the lab for further analysis. Field data on basidiocarps (site, habitat, association etc) was noted. Specimens were studied macroscopically and microscopically in the laboratory following the methods of Bessette et al. (2000). In the spore dimensions, the first values present the range of lengths and widths, and the values in parentheses present mean spore lengths and widths ± standard deviations followed Q_m ± standard deviation, where Q_m is the mean of Q (= length/width ratio of an individual spore). Other measurements are given as a range with exceptional values in parentheses. ECM were carefully placed in water to clean off soil particles and characterized morphologically under the stereomicroscope. The microscopic description of the ECM follows the terminology of Agerer (1991, 1999). Mantle views, emanating elements, and illustrations were documented with the help of

Table 1: rDNA sequences of *Suillus* species from Pakistan retrieved from GenBank for phylogenetic analysis.

Name	Accession no.	Isolate No.	Origin	Source
Suillus bellinii	AY898621.1	CCMA-22	Spain	Fruitbody
Suillus bovinus	AY898623.1	CCMA-67	Spain	Fruitbody
Suillus brevipes	FJ845440.1	SMI330	Canada	Fruitbody
Suillus caerulescens	EU486453.1	UBC F16304	Canada	Fruitbody
Suillus collinitus	AY953421.1	ECM 14	Spain	Ectomycorrhiza
	DQ440569.1	CCMA-73	Spain	Fruitbody
Suillus flavidus	—	2C	Pakistan	Fruitbodies
	—	2D	Pakistan	Fruitbodies
	—	2H	Pakistan	Fruitbodies
	—	3H	Pakistan	Fruitbodies
	—	H10	Pakistan	Fruitbodies
	—	10B	Pakistan	Fruitbodies
	—	2H 10H	Pakistan	Ectomycorrhiza
	—	3A 11G	Pakistan	Ectomycorrhiza
	—	8G	Pakistan	Ectomycorrhiza
	AJ971403.1	p12	UK	Ectomycorrhiza
	FJ845439.1	SMI206	Canada	Fruitbody
Suillus granulatus	AY898617.1	CCMA-02	Spain	Fruitbody
Suillus grevillei	AF347102.1	EL 38-99	Sweden	Fruitbody
Suillus lakei	DQ367917.1	OUC97024	Canada	Fruitbody
Suillus luteus	DQ440568.1	CCMA-37	Spain	Fruitbody
Suillus mediterraneensis	AY935512.1	CCMA-26	Spain	Fruitbody
Suillus quiescens	GQ249402.1	UC1860306	USA	Fruitbody
Suillus variegatus	AM086444.1	P17 F	UK	Ectomycorrhiza
	AM086446.1	P22 F	UK	Ectomycorrhiza

a camera lucida. Voucher specimens were deposited in the Herbarium, Department of Botany, University of the Punjab, Lahore, Pakistan (LAH).

Molecular analysis

DNA was extracted from dried basidiocarps using Extract N. Amp.TM Plant kit (SIGMA), and the nrDNA was amplified using fungal specific primers pair ITS3 (5′-GCATCGATGAAGAACGCAGC-3′) and ITS6-R (5′-TTCCCGCTTCACTCGCAGT-3′). Amplification parameters were denaturation at 94°C for 4 min., then 35 cycles of 45 s at 94°C, 45 s at 54°C, and 1 min 30 s at 72°C, and a final extension at 72°C for 2 min. The purified PCR products were sequenced bidirectionally by Macrogen (South Korea). The sequence was BLAST searched in GenBank for comparison with available sequences. To calculate percent identity, similarity, and divergence, selected sequences were aligned using Clustal W and corrected manually. All ambiguous insertions and deletions were removed prior to further analyses. Percent Identities (PID) and DNA divergence were calculated by DNAStar. Maximum Likelihood and Maximum Parsimony criteria were used to describe the phylogenetic placement with other species included in the present study. Phylograms were made using Mega5.

Taxonomy

Suillus flavidus (Fr.) J. Presl, Wšobecný rostl. 2: 1917 (1846) PLATE 1

PILEUS 3–9 cm wide, convex to hemispherical to nearly plane, sometimes slightly umbonate at maturity, sometimes margins straight and flaring to slightly deflexed with whitish remnants of veil, surface viscid to glutinous when wet, glabrous, yellow to yellowish brown. CONTEXT light yellow, browning when bruised, not bluing. STIPE 3–10 cm long, 1.5–2 cm thick, nearly equal, cylindrical, centric and curved, solid, slightly dry, reddish when young, yellow to white with reddish tinge when mature, whitish glandular dots in some case, whitish thick band like ring present above centre of stipe, color above ring yellow. PORE SURFACE yellow becomes slightly brown upon bruising, adnate and horizontal, pores angular to irregular, infrequent, about 2 per mm, tubes 3–9 mm deep. BASIDIOSPORES ellipsoid to fusoid, smooth, yellow, 9–13 × 4–6 µm, (11.3 ± 1.2 × 5.2 ± 0.6; Q_m = 2.26 ± 0.17). BASIDIA cylindric to long clavate, thick walled, yellowish brown contents visible in Meltzer's, 1–4 sterigmate, 22–26 × 8–10 µm. CYSTIDIA cylindrical to fusoid-ventricose, brown contents visible, thick walled, dark brown, 32–34 × 9–10 µm. PILEIPELLIS long, cylindrical to slightly clavate, thick walled, brown, 77–84 × 18–20 µm, most terminal cells cylindrical to clavate, in clusters and separate also, some are globose from above, dark brown, thick walled, 71–77 × 8–10(–14) µm. CHEMICAL REACTIONS pileipellis reddish in KOH, spores brownish in Meltzer's, light yellow to honey yellow in lactic acid. SMELL & TASTE not distinctive. EDIBILITY edible.

MATERIAL EXAMINED: **PAKISTAN: KHYBER PAKHTUNKHWA,** Ayubia, 2250 m a.s.l., under *Pinus wallichiana* A.B. Jacks., solitary, on ground, 19 July 2010, S. Sarwar (LAH S.B.#6A).

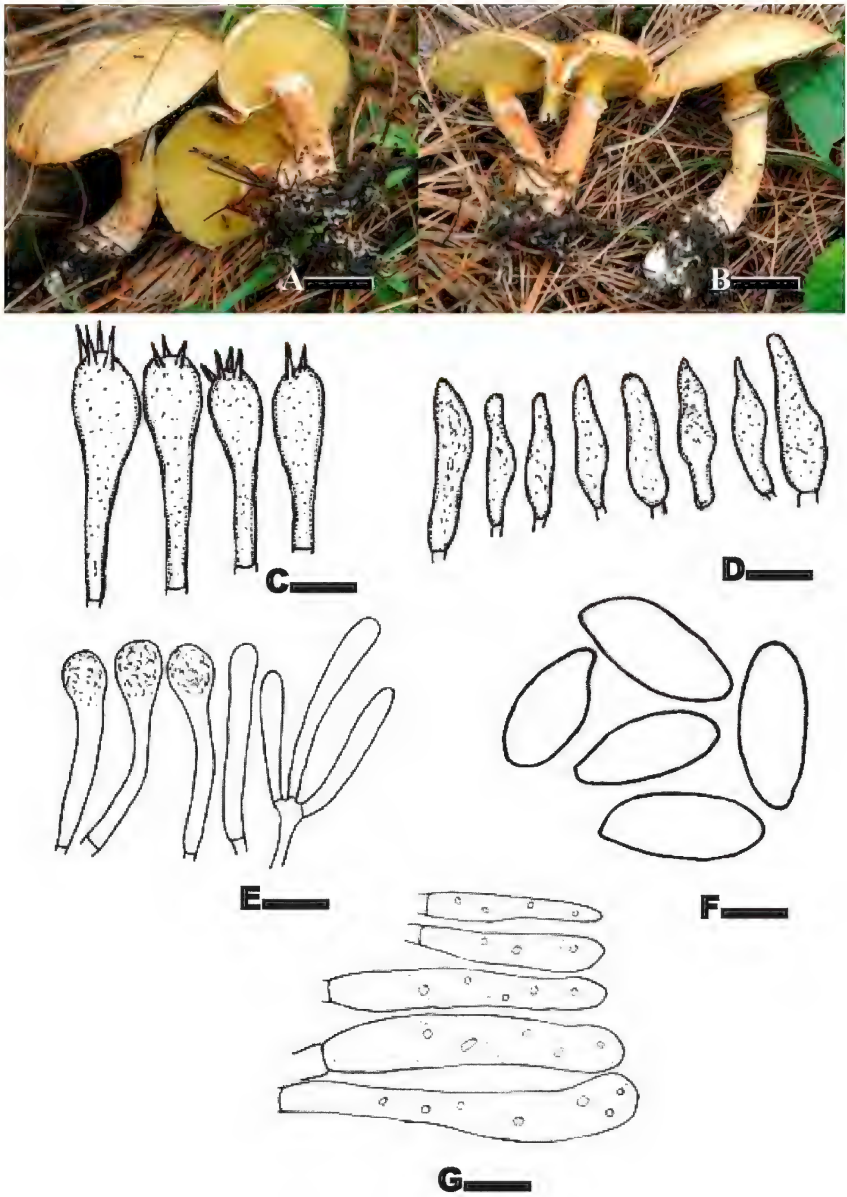

Plate 1. *Suillus flavidus*. A, B, Sporocarps; C, Basidia; D, Cystidia; E, Terminal cells of Pileipellis; F, Basidiospores; G, Pileipellis hyphae. Scale bars: A, B = 2.5 cm; C = 8 µm; D = 11 µm; E = 25 µm; F = 6 µm; G = 16 µm.

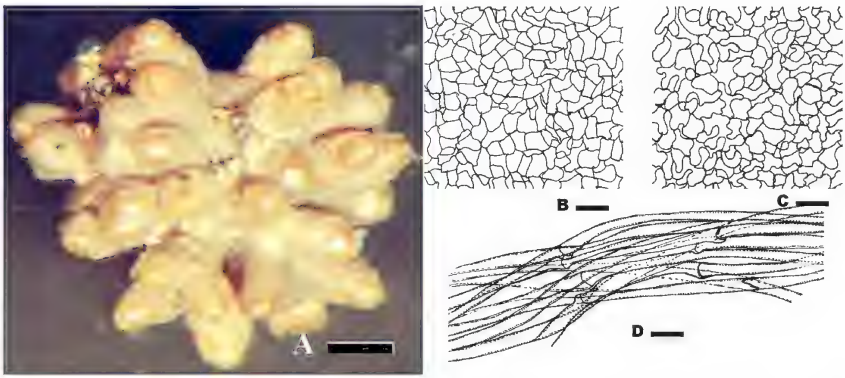

Plate 2. ECM of *Suillus flavidus* with *Pinus wallichiana* and its anatomical features. A, Habit; B, Parenchymatous outer mantle; C, Parenchymatous inner mantle; D, Rhizomorph. Scale bars: A = 1 cm; B = 9 µm; C = 8.5 µm; D = 19 µm.

Description of ectomycorrhizae of *Suillus flavidus*

Morphology — Plate 2A

Mycorrhizal system found under the fruiting bodies, highly dichotomously branched, system ≤ 5 mm long, with ≤ 0.8 mm thick main axis, unramified ends straight, ≤ 2 mm long, ≤ 0.5 mm diam., color of system reddish brown to dull yellow, older tips dark brown, apices light brown to honey brown, host tissue visible under the sheath. Rhizomorphs frequent and attached at restricted points, whitish brown.

Anatomy of mantle — Plate 2B,C

Mantle parenchymatous in all layers. Outer mantle parenchymatous (type L, Agerer 1987–2002); cells angular, 5 × 5 µm, honey brown, no matrix material, no septa and clamps observed. Inner mantle parenchymatous, (type M, Agerer 1987–2002); cells slightly angular, 4 × 4 µm, yellowish brown, no matrix material, no septa and clamps.

Anatomy of emanating elements — Plate 2D

Rhizomorphs slightly differentiated (type A, Agerer 1991), cells 26 × 7 µm, light brown, clamps common, septa less common and only at clamps, H-shaped anastomoses without clamps present. Emanating hyphae absent.

Material examined: **PAKISTAN: Khyber Pakhtunkhwa,** Ayubia, 2250 m a.s.l., Ectomycorrhizae Under *Suillus flavidus* near rhizospere of *Pinus wallichiana*, 19 July 2010, S. Sarwar (LAH S.B.#6B).

Molecular identification and phylogeny

When ITS-rDNA sequence was submitted for similarity with GenBank data, it was identified as *Suillus flavidus* with 98% maximum identity and 100%

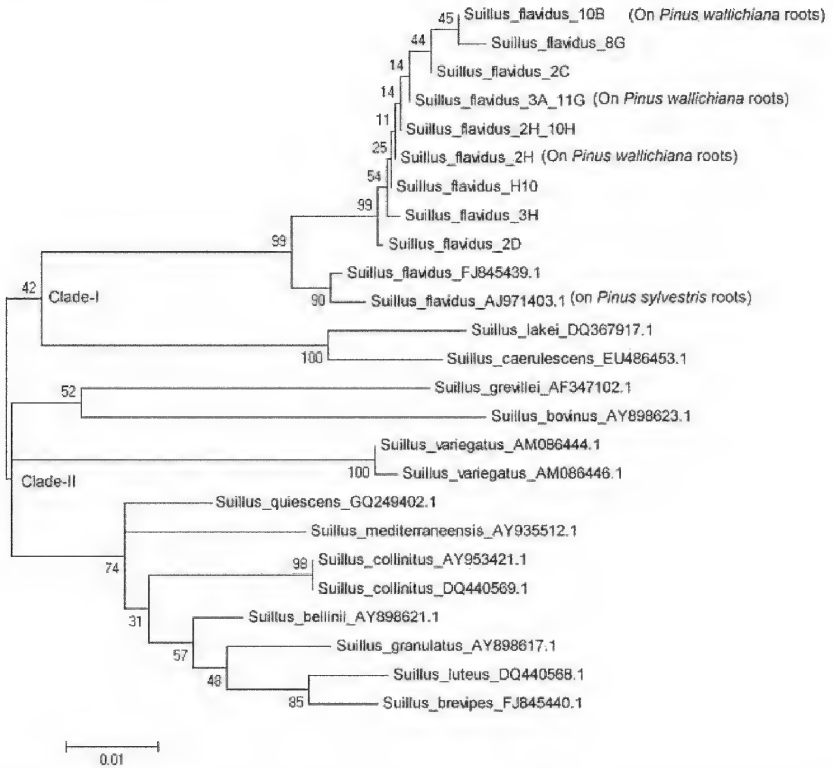

FIGURE 1: Molecular phylogenetic analysis by Maximum Likelihood method. The evolutionary history was inferred by using the Maximum Likelihood method based on the Poisson correction model (Zuckerkandl & Pauling 1965). The percentage of trees in which the associated taxa clustered together is shown next to the branches. Initial tree(s) for the heuristic search were obtained automatically as follows: when the number of common sites was <100 or less than one fourth of the total number of sites, the maximum parsimony method was used; otherwise BIONJ method with MCL distance matrix was used. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site. The analysis involved 25 sequences. There were a total of 426 positions in the final dataset. Evolutionary analyses were conducted in MEGA5 (Tamura et al. 2011).

query coverage with *S. flavidus* (FJ845439.1) from Canada. The phylogenetic analysis includes 25 sequences from 13 species (TABLE 1). For phylogenetic analysis, 426 genetic characters were used in aligned datasheet containing 330 conserved sites, 91 variable sites, and 66 parsimony sites. Phylogenetic analysis also supports the morpho-anatomic and molecular identification. The phylogram based on maximum likelihood criterion is represented by two major clades (FIG. 1). Clade I comprises 11 sequences from *S. flavidus*, *S. lakei* (Murrill) A.H. Sm. & Thiers (DQ367912.1), *S. caerulescens* A.H. Sm. & Thiers

(EU486453.1), and *S. grevillei* (Klotzsch) Singer (AF347102.1); their clustering is not highly resolved (bootstrap = 42%). *Suillus flavidus,* which occupies the top position in the phylogram, is represented by nine Pakistan sequences (six from fruitbodies and three from *P. wallichiana* ectomycorrhizal roots) and two GenBank sequences. The Pakistan rDNA-ITS sequences shared 100% genetic similarity with one another and about 98% with *S. flavidus* FJ845439.1. The two neighboring *S. flavidus* sister clades in clade 1 have a different topological placement due to intraspecific variations within the region sequenced. This species has a 92.1% genetic similarity with *S. lakei* DQ367912.1 and 91.6% with *S. caerulescens* EU486453.1. Genetic divergence was also measured for *S. flavidus* with all the sequences included in the analysis. No genetic divergence was found among the rDNA-ITS of *S. flavidus* from Pakistan (Fig. 2), and there was little genetic divergence (0.5–2.5) compared with *S. flavidus* FJ845439.1.

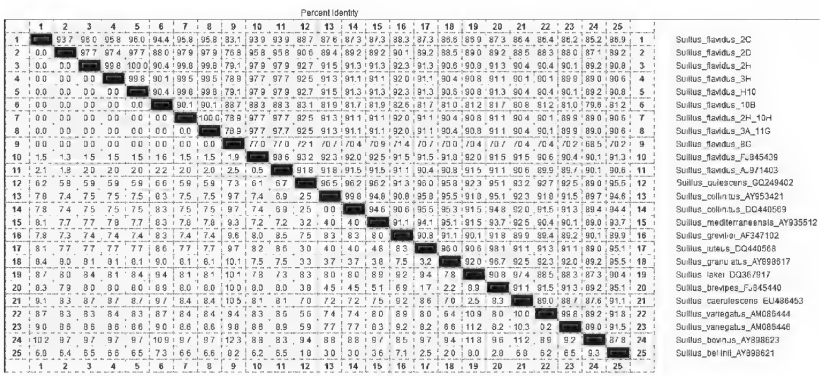

Figure 2: Percent divergence is calculated by comparing sequence pairs in relation to the phylogeny reconstructed by MegAlign (DNASTAR). Percent similarity compares sequences directly without accounting for phylogenetic relationships.

Discussion

We report *S. flavidus* and its ectomycorrhizae with *P. wallichiana* for the first time from Pakistan. This fungus is characterized by a convex to hemispheric yellowish pileus with reddish brown spots on the margin and typically small hanging veil remnants and a stipe with a prominent ring. Spores are smooth and range from light to dark brown. *Suillus flavidus* resembles *S. lakei*, which differs in a pileus surface covered with dull reddish brown scruffies and a stipe with reddish streaks and without glandular dots. The similar *S. caerulescens* also lacks glandular dots but has occasional appressed hairs on the stipe. Finally, *S. grevillei,* which is also resembles *S. flavidus,* has a somewhat reticulated stipe that lacks the glandular dots that characterize *S. flavidus* (Bessette et al. 2000).

We characterize *S. flavidus–P. wallichiana* ectomycorrhizae here for the first time by noting their highly dichotomously branched ramifications with parenchymatous inner and outer mantle surfaces, slightly differentiated rhizomorphs, and no emanating hyphae. Different Pakistani ectomycorrhizae associated with *Cedrus deodara* have recently been molecularly analyzed (Hanif et al. 2010) but there is no literature on molecular description of ectomycorrhizae of boletes from Pakistan. We report *S. flavidus* as new record for Pakistan and believe that *P. wallichiana* is documented here as a new ectomycorrhizal host for *S. flavidus* for the first time.

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Russulaceae of the Pakaraima Mountains of Guyana 2. New species of *Russula* and *Lactifluus*

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Abstract— Morphological and ecological descriptions, illustrations, and taxonomic discussions are presented for a subiculate species of *Lactifluus*, *L. subiculatus*, and three species of *Russula*, *R. myrmecobroma*, *R. paxilliformis*, and *R. gelatinivelata*, all newly described from the Pakaraima Mountains of Guyana. Sequence data confirm relationships of taxa collected in Guyana within a large *Russulaceae* database.

Key Words— basidiomycetes, *Basidiomycota*, biodiversity, ectomycorrhiza, macrofungi, neotropics, *Russulales*

Introduction

A recent paper (Henkel et al. 2011) documented for the first time the sporocarp diversity of putative or confirmed ectomycorrhizal fungi in lowland tropical forests of Guyana. In that study, conducted over a ten year period from 2000 to 2010, sporocarps from 172 species of macrofungi representing 13 families and 25 genera of primarily *Agaricomycetes*, but also *Ascomycota* (*Elaphomycetaceae*), were collected from plot studies and opportunistic exploration of the *Dicymbe* (*Fabaceae* subfam. *Caesalpinioideae*) dominated forests of the Upper Potaro River Basin. Of these families, the *Russulaceae* contained the most species, many new to science.

The present communication provides macro-, micromorphological, and ecological descriptions and illustrations for four new taxa in the *Russulaceae* that contributed significantly to the biodiversity in the aforementioned plot studies (Henkel et al. 2011). Taxonomic discussions are also provided, guided by sequence analyses that will be detailed elsewhere.

Materials & methods

Collecting expeditions were made in the rainy seasons (typically May–July) 2000–2011 to the Upper Potaro River Basin along Guyana's western border with Brazil, in the south-central Pakaraima Mountains (general area: 5°05′N 59°58′W). Basidiomata were examined in the field for fresh characteristics. Color characteristics were coded according to Kornerup & Wanscher (1981; code noted in parentheses) and described subjectively. Spore deposits were taken on acetate sheets and examined for fresh color characteristics. The $FeSO_4$ macrochemical test was performed using a large mineral crystal that was rubbed directly on the stipe, lamellae and flesh. Basidiomata were dried slowly using large bead silica gel and subsequently placed in re-sealable plastic bags with small bead silica gel to prevent spoilage in the excessively humid conditions. In addition, basidiomata in various stages of development were immersed in ethanol for preservation and for molecular analysis. DNA extraction, sequencing and molecular analysis were generally those described in Miller et al. (2006).

Microscopic anatomical details were determined from dried basidiomata with an Olympus BH–2 microscope with bright-field optics and drawings were made with a camera lucida attachment. For basidiospores at least 20 individuals were observed and measured per taxon. The acid resistant reaction in basic fuchsin, the cresyl blue reaction, and the sulfovanillin reaction were prepared according to Singer (1986).

Herbaria designations are after Holmgren et al. (1990) and include: BRG – University of Guyana, Georgetown; HSU – Humboldt State University; RMS – Solheim Mycological Herbarium; LSUM – Louisiana State University Bernard Lowy Mycological Herbarium.

Taxonomy

Lactifluus subiculatus S.L. Mill., Aime & T.W. Henkel, **sp. nov.** PLATES 1–2

MYCOBANK MB 564265

Sed Lactifluus subiculatus *atrohervolo pileo maturo et crustoso, versus gracili tomentoso stipite differt.*

TYPE: Guyana, Pakaraima Mountains, Upper Potaro River Basin, *Dicymbe altsonii* stand, 22.V.2000, SL Miller 10047 (**Holotype**, RMS; **isotype**, BRG; GenBank JQ405654).

ETYMOLOGY: *subiculatus* (Lat.), referring to the dense subiculum from which the basidiomata arise.

PILEUS 0.9–3 cm broad, at first convex, then plane to slightly depressed to irregularly infundibuliform; margin incurved and regular when young, then decurved, entire to undulating, obscurely striate at first, then irregularly subsulcate when older; extreme margin distinctly membranous for up to 1 mm; pellis finely velutinous to hispidulose or subtomentose when young, then rugulose and minutely areolate especially at the disk, tacky to slightly lubricous when moist, light brown (6D6–8) overall impression, light brown (6D6–8) to yellowish brown to golden brown (5D6–8) when young, mottled and streaked with pale to light orange (5A3–4) and less frequently with brown (6E–7) with age, with extreme margin pale orange white. LAMELLAE 2–3.5 mm wide at

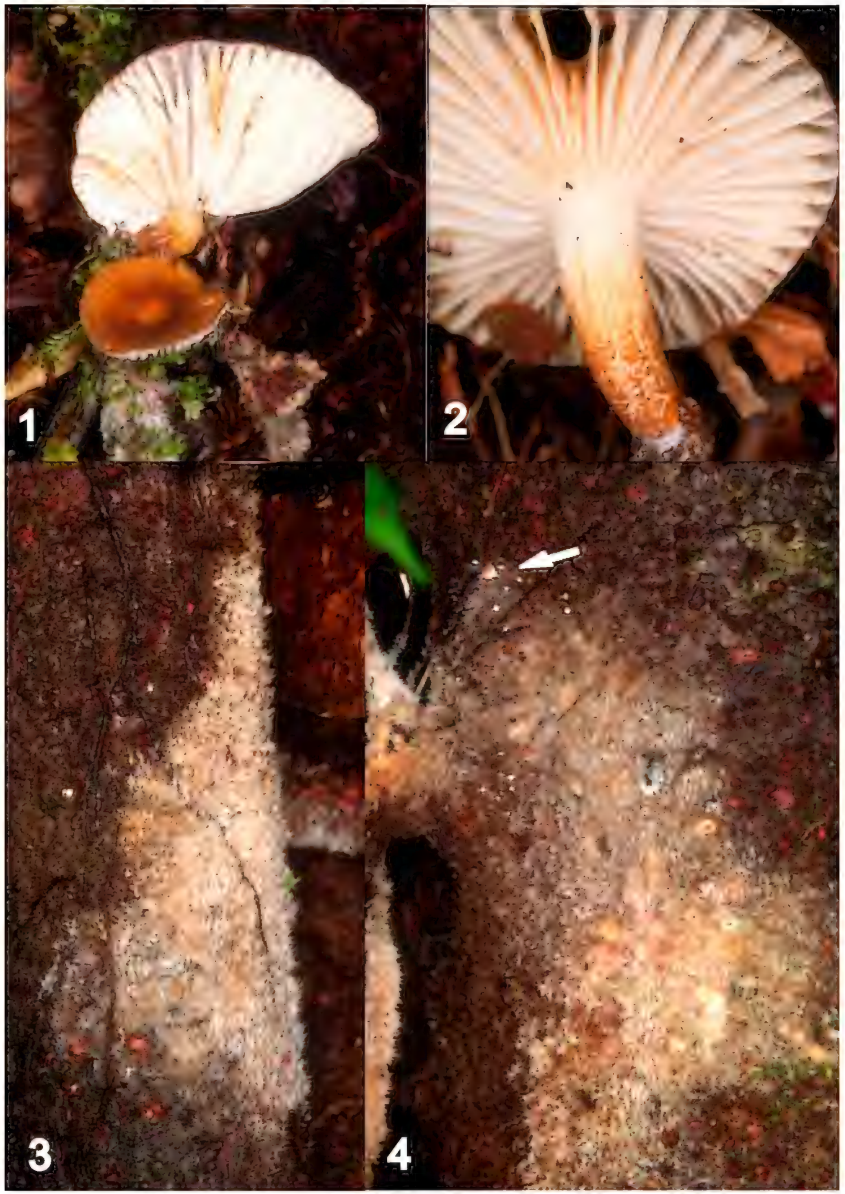

Plate 1. *Lactifluus subiculatus* habit (Miller 10047). 1. Basidiomata produced on shaggy subiculum enshrouding base of sapling, ×1.8. 2. Stipe showing disrupted crust of pigment and minutely fluted topography, along with lamella morphology, ×2.1. 3–4. Extensive subiculum on boles of large *Dicymbe corymbosa* trees. 3. ×0.15. 4. Arrow indicates *L. subiculatus* basidiomata and cluster of primordia, ×0.2.

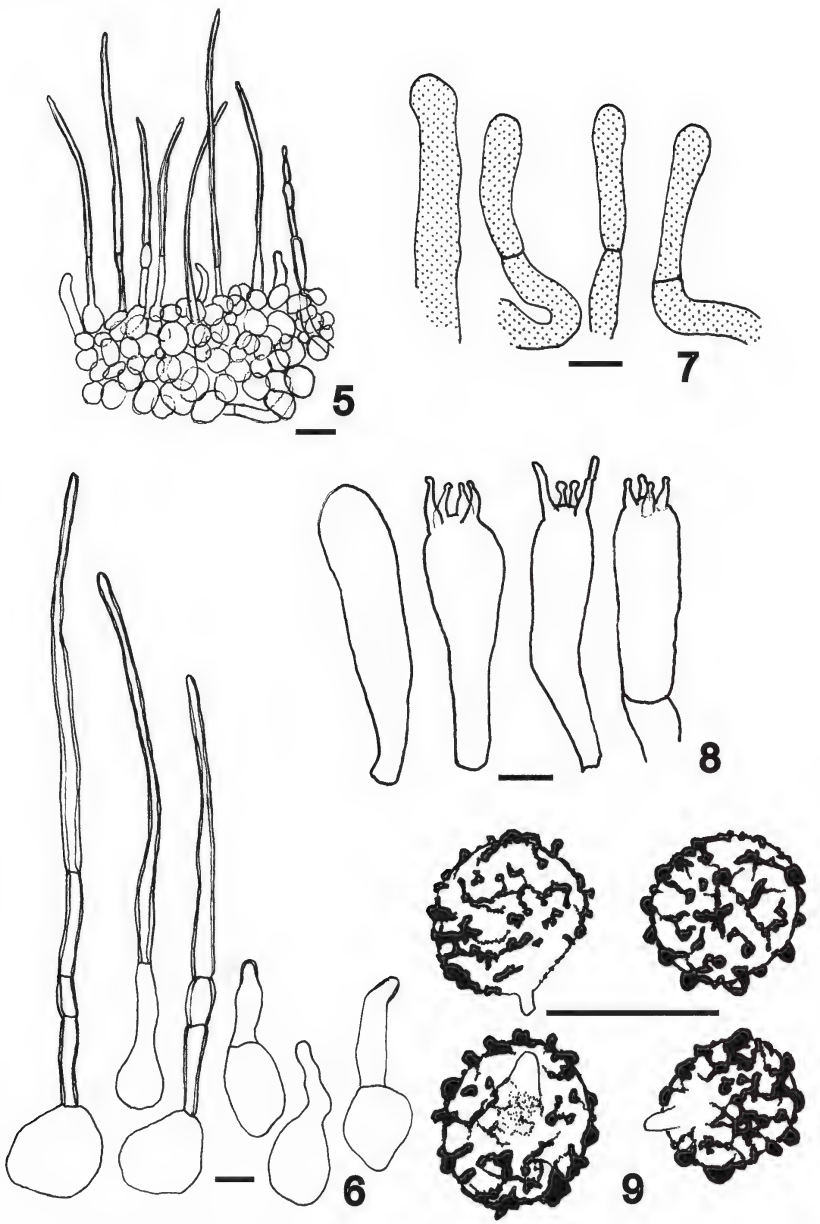

Plate 2. *Lactifluus subiculatus* (Miller 10047), microscopic features. 5. Diagram of a section of the two-layered pileipellis; the suprapellis is a lampropalisade of thick-walled hairs over a pseudoparenchymatous subpellis. 6. Elements of the suprapellis. 7. Gloeopleurous hyphae. 8. Basidia. 9. Basidiospores. Scale bars = 10 μm.

mid-radius, irregularly adnate to subdecurrent, unequal, close when young then subdistant, not or occasionally intervenose and forking, thin at first then moderately thick, rounded, white to pale yellow (4A3–4 to 5A2), unchanging; edge entire, concolorous; lamellulae of three different lengths. Stipe 4–8 × 8–15 mm, cylindrical, equal or tapered to the base, curved, attachment central, occasionally distinctly fluted, yellowish white to pale creamy tan (4A2 to 5B4–5) above, concolorous with pileus below, subvelutinous toward the base at first, then this tissue cracking into distinct isolated patches; arising from a thin, coarse, erect tomentose subiculum. Context 1–2 mm at mid-radius, firm, solid in lamellae and stipe, white, unchanging; odor strong fungal; taste disagreeable. Latex absent or scant, watery, unchanging. $FeSO_4$ quickly dull green on lamellae and trama. Subiculum usually distinct and extensive, shaggy, off-white to greyish cream, composed of fascicles of hyaline, linear hyphae or hairs 2–8 µm wide, thick-walled (≤ 2–2.5 µm).

Basidiospores 7.6–9.2(–9.6) × 6.4–7.6 µm (Q = 1.18–1.21–1.26), subglobose to short ellipsoid; ornamentation amyloid, composed of irregularly sized and shaped warts; warts 0.5–1.0 µm high, usually obtuse, isolated or connected by fine lines forming a fine partial reticulum; hilar appendix prominent, 3–4 × 1.5–2 µm, hyaline; suprahilar plage non amyloid or with faint fine reticulum, rarely with an isolated amyloid spot. Basidia clavate, 45–60 × 15–18 µm, 4–spored, sterigmata 7–9 × 1–2 µm. Pseudocystidia 5–10 µm wide, cylindrical or irregularly contorted, rounded or blunt-pointed at the apex, not emergent, infrequent to abundant, thin-walled; contents refractive granular, SV–; connected deeply to laticiferous hyphae in the trama with similar contents. Pleurocystidia absent. Hymenophoral trama irregular, composed of interwoven, hyaline, thin-walled hyphae, which are 3–5 µm diam with scattered inflated cells of 8–10 µm wide; lactiferous hyphae scattered, 8–11 µm wide with refractive guttulate contents; sphaerocytes rare or absent; subhymenial layer not well developed. Pileipellis a sparse to dense lampropalisade; elements of suprapellis 35–150(–220) × 5–10 µm, cylindrical, hair-shaped, septate, with wall 1–2 µm thick, frequently with swollen base; subpellis pseudoparenchymatous; cells isodiametric, obovate, napiform to obpyriform, 10–40 µm diam, with yellowish brown contents in KOH, cylindrical to slightly contorted; all cells SV–. Stipitipellis similar to pileipellis but hair-like elements less numerous, surface tissue often nearly occluded by external yellowish brown amorphous pigment in KOH; SV–.

Habit, habitat, and distribution – Solitary to fruiting in small numbers on lower trunks of saplings, larger trees, stumps and other elevated positions, arising from a shaggy, often deep and extensive, persistent subiculum which enshrouds living and dead objects above the surface of the ground and which is often interspersed with or overriding bryophyte growth, subtended by

ectomycorrhizal rootlets; found May through early July during wet weather in forests dominated by *Dicymbe corymbosa* and *D. altsonii*. Ectomycorrhizal associations with the leguminous hosts in Guyana were confirmed with the aid of molecular analysis (Smith et al. 2011)). Known only from the type locality in the Upper Potaro Basin of Guyana, and Mabura.

Additional specimens examined. **GUYANA. Region 8 Potaro–Sipiruni.** Pakaraima Mountains, Upper Potaro River Basin, within 5 km radius of Potaro base camp located at 5°18′04.8″N 59°54′40.4″W, 710–750 m, 17.V.2000, Miller 10010 (BRG, RMS); Miller 10021 (BRG, RMS); 28.VII.2000 Henkel 7922 (BRG; HSU). Near Ayanganna Airstrip, 16.V.2000, Miller 10004 (BRG, RMS); 20.V.2000 Miller 10034 (BRG, RMS). ***Dicymbe altsonii* stand**, 22.V.2000 Miller 10047 (BRG, RMS). *Dicymbe* Research Plots, 27.V.2000, Miller 10061 (BRG, RMS); 1.VI.2000, Miller 10087 (BRG, RMS); 3.VI.2000, Miller 10094 (BRG, RMS); 8.VI.2000 Miller 10114 (BRG, RMS). Vicinity of base camp, 28.VII.2000, Henkel 7922 (BRG, HSU); 15.V.2010 Aime 3937 (BRG, LSUM). ~3 km SE of Potaro base camp near *Dicymbe* plot 1, 25.V.2001, Henkel 8210 (BRG, HSU). 1 km SW of base camp near Blackwater point, 10.VII.2010, Henkel 9020 (BRG, HSU). Near *Dicymbe* Plot 2, 26.V.2010, Henkel 9229 (BRG, HSU). **Region 10–Upper Demerara-Berbice.** Mabura Ecological Reserve, *Dicymbe altsonii* stand, 24.V.2011 Aime 4276 (BRG, LSUM).

Commentary – Previously, three neotropical species of *Lactarius* that produce basidiomata from an extensive and well developed subiculum have been described (Singer 1984; Miller et al. 2002; Miller & Henkel 2004): *L. panuoides* Singer, *L. brunellus* S.L. Mill. et al., and *L. multiceps* S.L. Mill. et al.. *Lactarius panuoides* and *L. brunellus* are pleurotoid, while *L. multiceps* has a short, but occasionally well-developed, eccentric stipe (Miller et al. 2002). The stipe of the milkcap described here is larger and centrally attached, and the basidioma stature is typically more agaricoid than pleurotoid. Molecular data confirm that our species forms ectomycorrhizae with the leguminous hosts *D. corymbosa*, *D. altsonii*, and *Aldina insignis* in Guyana (Smith et al. 2011).

The infrageneric placement of *L. subiculatus* is unclear. It is clear that the species belongs to *Lactifluus*, which was recently split from *Lactarius* (Buyck et al. 2008, 2010; Verbeken et al. 2012). The rDNA molecular phylogenetic analysis (SL Miller, unpublished) indicates a close relationship with *Lactifluus neotropicus* (Singer) Nuytinck, originally described from Trinidad, but collected also from Guyana (SL Miller, unpublished). The combination of long thick-walled hairs in the suprapellis arising from an epithelioid subpellis (which both species share) is characteristic of several *Lactifluus* groups in both the old- and new-world tropics, including *L.* sections *Lactariopsis* Verbeken, *Chamaeleontini* (Verbeken) Verbeken, *Pseudogymnocarpi* (Verbeken) Verbeken, *Phlebonemi* (R. Heim ex Verbeken) Verbeken, and *Polysphaerophori* (Singer) Verbeken (Pegler & Fiard 1979, Singer et al. 1983, Verbeken & Walleyn 2010). Singer (Singer et al. 1983) and Pegler & Fiard (1979) differentiated sections *Lactariopsis* and *Polysphaerophori* by the presence of a partial veil or, more precisely, an annulus

or remnants of a veil on the stipe in sect. *Lactariopsis*. Similarly, Verbeken & Walleyn (2010) distinguished sect. *Lactariopsis* from sect. *Chamaeleontini* based on the presence of an annulus in the former. Sect. *Polysphaerophori* Singer, erected for South American species (Singer 1973), was used to place the African "*Gymnocarpi*" by Verbeken & Walleyn (2010), who rightly recognized the artificial distinction between several of these groups and maintained them only for practical reasons.

Macroscopically, the brownish orange colours and pilose to velutinate pileus surface, and microscopically, the abundant sphaerocytes in the hymenophoral trama, the thick-walled elements in the pileipellis, and spores with low ornamentation forming a partial to nearly complete reticulum in *L. subiculatus* are consistent with *L.* sect. *Lactariopsis*. Although *L. subiculatus* has not been observed to form a distinct annulus, the extreme margin does have a distinct flap of tissue that may be easily interpreted as the remnants of a partial veil.

The other subiculate species, *L. multiceps*, *L. brunellus* and *L. panuoides*, have not yet been recombined in *Lactifluus*. They all combine the subiculate character with a pleurotoid habit and, up to now, all pleurotoid milkcaps that have been molecularly investigated belong to *Lactifluus*.

Russula myrmecobroma S.L. Mill., Aime & T.W. Henkel, **sp. nov.** PLATES 3–4

MYCOBANK MB 564264

Ab aliis speciebus Russulae *stipite cinereo, pileo fusco, deinde irregulariter diaphano ubi udo et fascianti in centro propriam ordinationem reticulatam, ordinate dispositis striis pro longitudine aequalibus, lamellis aggregatis et sapore acris differt.*

TYPE: Guyana, Pakaraima Mountains, Upper Potaro River Basin, near Hogback Ridge, 5.VI.2000, SL Miller 10109 (**Holotype**, RMS; **isotype**, BRG; GenBank JQ405657).

ETYMOLOGY: *myrmecobroma* (Gk.), literally ant food, referring to the regular dismemberment of the basidiomata by ants.

PILEUS 3.5–4.5 cm broad, broadly convex at first, then plane and finally depressed; margin entire when young, then undulating, obscurely striate at first, then with regularly spaced and sized striations; striations 2 mm long; pellis dull, dry, smooth at disk, frequently pruinose at mid-radius and at margin, yellowish brown (5E–F–8 to 5D–E 5) overall at first, becoming hygrophanous with irregular reticulate pattern especially halfway the radius and with color fading to dark blond (5C–4, 5C–D–3) to orange grey (5B–2) with irregular areas of 5B–3–5; disk and margin not hygrophanous and usually remaining darker. LAMELLAE 1–2 mm broad at mid-radius, adnate, sinuate or slightly subdecurrent, crowded, forked at stipe and occasionally elsewhere, arising at different positions relative to the stipe giving uneven appearance, pallid cream (near 4A–2), becoming spotted with yellow or reddish brown where injured; lamellulae present, 4–5 ranked; edge entire. STIPE 3–5.7 × 0.8–1.1 cm, equal to subclavate or tapering to the base, centrally attached, moderately distinct

Plate 3. *Russula myrmecobroma* habit. 10. Bisected basidiome (Miller 10109), ×1.1. 11. Basidiome (Miller 10161) exhibiting damage by ants (arrow), ×1.2.

longitudinal ridges beneath felted subtomentose covering especially below, tomentum white to pale grey (5A–B–1), pale orange grey (5B 2–3) beneath, grey brown where handled and where longitudinal ridges become exposed. Context in pileus 2–2.5 mm at mid-radius, stuffed pallid grey cream; context in stipe cylinder whitish marbled with pale grey, turgid to pliant, pallid cream to pale grey brown, discoloring pale orange or orange brown where injured; odor sharp acrid heading toward latex paint; taste strongly acrid; $FeSO_4$ quickly salmon on stipe surface and trama.

Basidiospores 6.4–7.2(–8) × 5.6–6.8 µm (Q = 1.05–1.14–1.17), subglobose to broadly ellipsoidal; ornamentation reticulate, consisting of low blunt spines, 1–1.3 µm high, connected by fine lines or verrucae, strongly but often partially amyloid; suprahilar plage not distinct to finely reticulate. Basidia 55–62 × 12–15 µm, subclavate to nearly cylindrical, 4–spored; sterigmata stout 7–10 × 2–3 µm. Cystidia 80–95 × 15–20 µm, subclavate to subfusiform, thin or thick walled, emergent for ca. 20–30 µm, numerous, arising from gloeopleurous elements, with refringent to crystalline contents, SV+, thick walled lamprocystidia present but not numerous. Marginal cells 55–105 × 8–15 µm, narrowly subclavate, tortuous, thin-walled, optically empty, abundant. Subhymenium distinct, a gelatinous layer composed of interwoven cylindrical flattened and variously swollen hyphae of 2–5 µm diam. Lamellar trama with large sphaerocytes and scattered hyphae, with gloeopleurous fragments and embedded dermatocystidia near the pileus. Pileipellis orthochromatic in Cresyl Blue, two-layered; subpellis gelatinized, forming a dense mat close to the underlying trama, of tightly interwoven hyphae; hyphae 2–5 µm diam, thin-walled, frequently septate, with scattered strongly refringent gloeopleurous elements of 5 µm diam, frequently terminating with cylindrical to swollen or mucronate

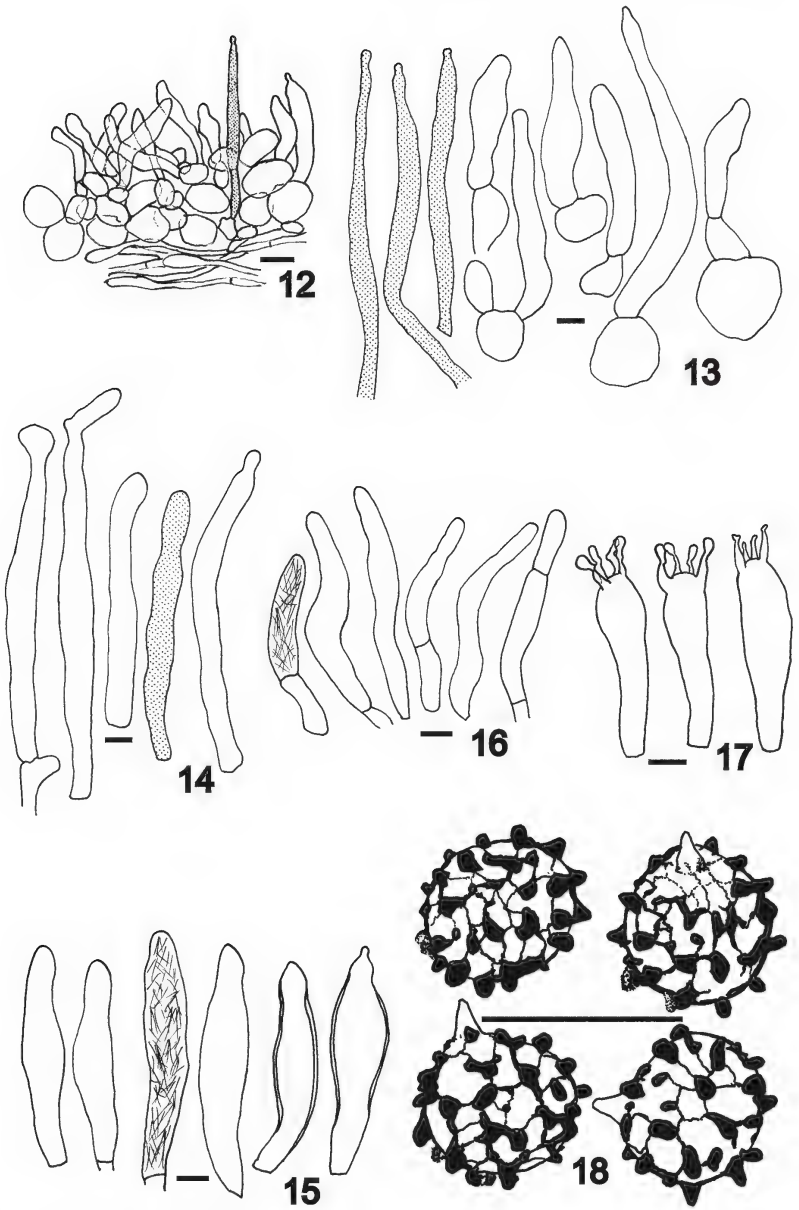

Plate 4. *Russula myrmecobroma* (Miller 10109), microscopic features. 12. Diagram of a section of the two-layered pileipellis; the suprapellis is a trichodermial palisade over a thin pseudoparenchymatous subpellis. 13. Elements of the suprapellis. 14. Elements of the stipitipellis. 15. Hymenial cystidia. 16. Marginal cells. 17. Basidia. 18. Basidiospores. Scale bars = 10 μm.

embedded dermatocystidia; suprapellis composed of 2–5 strongly inflated, spherical cells, often gradually smaller towards the terminal cell, the latter cylindrical to narrowly subclavate, ampullaceous, or mucronate, resembling an epithelium; pileocystidia dispersed, terminal, more or less the same diam. as other terminal elements, 50–90 × 10–13 µm, contents granular-refringent in KOH. Stipitipellis a turf of variously shaped caulocystidia, 100–170 × 9–14 µm, these narrowly cylindrical, mucronate, capitate or tortuous.

Habit, habitat, and distribution – Solitary or fruiting in small numbers on root mats of the ECM trees *Dicymbe corymbosa*, *D. altsonii*, *D. jenmanii*, *Aldina insignis* and *Pakaraimaea dipterocarpacea*, widespread in the Pakaraima Mountains but not common; found May through early July during wet weather and also in December–January. Known from Mabura Hill and the Upper Potaro and Upper Mazaruni River Basins of Guyana.

Additional specimens examined: **GUYANA. Region 8 Potaro–Sipiruni.** Pakaraima Mountains, Upper Potaro River Basin, within 15 km radius of Potaro base camp located at 5°18′04.8″N 59°54′40.4″W, 710–750 m. Vicinity of Potaro Base Camp, 21.V.2000, Miller 10045 (BRG, RMS); 24.VI.2000, Miller 10161 (BRG, RMS). ~3 km SW of base camp near *Dicymbe* plot 3, 8.VI.2001 Henkel 8258 (BRG; HSU). 1 km SW of base camp near Blackwater point, 10.VII.2009, Henkel 9016 (BRG; HSU). 15 km east of Potaro base camp near Tadang base camp, in mixed *Dicymbe corymbosa–Dicymbe altsonii–Aldina insignis* forest, 24.XII.2009, Henkel 9145 (BRG; HSU). *Dicymbe* plot 1, 5.VI.2001, Aime 1783 (BRG, LSUM); 15.V.2010, Aime 3935 (BRG, LSUM). *Dicymbe* plot 2, 6.VI.2001, Aime 1823 (BRG, LSUM). **Region 7 Cuyuni–Mazaruni.** Pakaraima Mountains, within 1 km radius of Piegaimah base camp at 5°26′21.3″N 60°04′43.1″W. Vicinity of base camp, in savanna fringing forest under *Pakaraimaea dipterocarpacea* and *Dicymbe jenmanii*, 24.XII.2010, Henkel 9523 (BRG; HSU). ~1 km SW of base camp, in stand dominated by *Pakaraimaea dipterocarpacea* and lacking *Dicymbe jenmanii*, 26.XII.2010, Henkel 9546 (BRG; HSU). **Region 10–Upper Demerara-Berbice.** Mabura Ecological Reserve, *Dicymbe altsonii* stand 1, 1.VI.2011, Aime 4360 (BRG, LSUM).

Commentary – It is relatively difficult to find fresh basidiomata of *R. myrmecobroma* that have not been extensively damaged by ants. While ants will disarticulate and carry off pieces of a variety of fungal fruiting structures, they seem to be especially attracted to *R. myrmecobroma*, and in Guyana only *R. batistae* Singer seems to be more attractive. Microscopically both fungi appear to have relatively primitive traits such as an abundant gloeoplerous system with embedded dermatocystidia in the pileipellis and abundant macrocystidia of two types deeply rooted in the hymenium, all strongly positive in sulfovanillin. Both also have an acrid to strongly acrid taste. It is unknown whether any of these characteristics serve as an attractant to the ants.

From an ecological standpoint, *R. myrmecobroma* may be a quite important mycorrhizal symbiont in Guyana's *Dicymbe* forests. In a recent study by Smith et al. (2011) in the Upper Potaro Basin, *R. myrmecobroma* was the most frequently ECM fungus out of 118 taxa recovered by molecular methods on

ECM roots of 19 trees each of three sympatric host species, *D. corymbosa*, *D. altsonii*, and the papilionoid *Aldina insignis*. In a second study (ME Smith & TW Henkel, unpublished) investigating mycorrhizal symbionts of the ECM dipterocarp, *Pakaraimaea dipterocarpacea*, and the sympatric *Dicymbe jenmanii* in the Upper Mazaruni Basin, *R. myrmecobroma* was the sixth most common mycobiont recovered among about 50 species of EM fungi associated with 20 trees of each host species, indicating a broad host and distribution range for the fungus in Guyana. It is interesting to speculate that movement of tissue pieces by the ants might contribute to the frequency of *R. myrmecobroma* in the forest.

Molecular analysis (SL Miller, unpublished) indicates a close relationship between *R. myrmecobroma* and *R. batistae*, despite the fact that macroscopically they are very different. *Russula batistae* has irregular, broad, subdistant to distant lamellae, no lamellulae, and a deeply sulcate pileus margin, while *R. myrmecobroma* has regular, rather narrow, crowded lamellae, abundant lamellulae, and a regularly short-striate margin. Singer erected *R.* subsect. *Batistinae* in the large section *Pellicullariae* to accommodate *R. batistae*. This subsection likely will not suffice as no velar tissue has been observed in *R. myrmecobroma*, suggesting a need to refine the description of the subsection. Buyck (1990a) has shown that *R.* sect. *Pellicullariae* is highly heterogeneous and possibly not monophyletic, indicating the possible need for a new infrageneric group at the sectional level to accommodate *R. batistae* and *R. myrmecobroma*.

Russula paxilliformis S.L. Mill., Aime & T.W. Henkel, **sp. nov.** PLATES 5–6

MYCOBANK MB 564266

Pagina pilosa rupenti in fine squamellas tenues prope marginem, exponenti texturam pallidam et stipitem velutinum basin versus decrescentem et sine profunde striato margine.

TYPE: Guyana, Pakaraima Mountains, Upper Potaro River Basin, vicinity of Potaro Base Camp, 3.VI.2000, SL Miller 10097 (**Holotype**, RMS; **isotype**, BRG; GenBank JQ405656).

ETYMOLOGY: *paxilliformis* (Lat.), referring to the pilose pileus with inrolled margin and coloration reminiscent of *Paxillus involutus*.

PILEUS 3–8.5 cm broad, convex at first with deeply depressed disk, becoming plane or uplifted, often with a hole entirely through the disk of the pileus where ants have eaten away the tissue; margin tightly inrolled around stipe at first with a frail tomentose partial veil connecting margin to stipe, in age margin becoming separated, then decurved, and finally plane leaving no annulus or other trace of a veil, entire, not striate when young, becoming obscurely striate with age; pellis dull, dry, densely subtomentose to velutinous when young, concentrically cracking to become areolate, granulose to squamulose,

Plate 5. *Russula paxilliformis* habit. 19. Top surface of unexpanded pileus showing radial cracking of pilose pellis (Miller 10097), ×1.8. 20. Top surface of expanded pileus showing radial cracking at the disk and areolate or granulose texture near the margin (Miller 10097), ×0.8. 21. Side view of unexpanded pileus showing tightly inrolled and pale colored margin, and subtomentose and ornamented stipe (Miller 10097), ×1.8. 22. Mature basidiome with partially expanded pileus showing velar remnants at the margin, and subtomentose stipe (Miller 10070), ×0.9.

remaining so especially at the disc; pileus and partial veil light brown to golden brown (5C–D 6–7) overall, disk yellowish brown (5D6–8) when young, with an orange white subcutis (near 5A–2) showing through, with age areoles (?) darkening to brown (6E 7–8) with orange white 5A–2 or light brown (near 6D4–5) showing through, disk brown (6–7 E 6–7). Lamellae 3–4 mm broad at mid-radius, adnate to slightly decurrent, close, rarely forking at stipe and

elsewhere, entire, firm when young, soft with age, whitish to cream, discoloring pale reddish brown where handled; lamellulae absent. Stipe 5.5–8 × 0.9–1.0 cm, cylindrical to tapering to the base when young, strongly tapering to the base and often flared at the apex in age, usually with a pronounced depression around stipe apex where tightly inrolled pileus and partial veil were connected, commonly curving, attachment central, even, highly tomentose to scurfy, with more or less concentric areolate stretch marks when older, matted to flocculose where handled; light brown to golden brown (5 C–5–7 to 5D–5–8), at first areolae yellow brown (5E–8, with age 5E–6–7), over light brown (5C–5–6) ground beneath, then yellowish white to pale creamy tan (4A2 to 5B4–5) above, light brown to brown (5–6D –6–7) or dark brown (6F5–6) below. Context in pileus 2.5–3 mm at mid-radius, firm at first, then soft, pallid cream; trama in stipe with distinctive anatomy in longitudinal section, with a discrete separable cylinder-like plug of hard tissue forming a central core from pileus in upper two thirds of the stipe, surrounded by firm tissue comprising most of the stipe, outer cylinder marbled bluish steel gray from base over lower one-half, in older specimens the central core has frequently been completely eaten away by ants so that the stipe is hollow; odor strongly fungal, like *Scleroderma;* taste disagreeable at first, then slowly acrid; $FeSO_4$ quickly salmon on stipe trama.

Basidiospores (6.8–)7.2–7.46–8 × 6–6.8(–7.2) µm (Q = 1.06–1.13–1.27), subglobose to broadly ellipsoidal; ornamentation reticulate or incompletely reticulate; ornamentation consisting of partial crests with short lateral diverticulations and large broadly conical or multiplex blunt spines, 1.6–2.8 µm high, connected by fine lines or verrucae, strongly but often partially amyloid; suprahilar plage moderately large, verruculose, barely decurrent on apiculus. Basidia 50–65 × 12–15 µm, subclavate to subcylindrical, 4-spored; sterigmata 8–10 × 1–3 µm. Cystidia 70–95 × 6–13 µm, cylindrical to subfusiform, obtuse, deeply rooting, mostly thin-walled, emergent 30–35 µm above basidia, SV+, contents crystalline, numerous. Marginal cells 65–105 × 10–18 µm, cylindrical to subfusiform, SV+, numerous. Trama of lamellae and pileus composed of large well-developed nests of sphaerocytes; subhymenium not well developed. Pileipellis orthochromatic in Cresyl Blue, two-layered; subpellis of loosely interwoven hyphae of 4–5 µm diam. with scattered gloeoplerous elements of 5 µm diam., pale brownish grey in SV; suprapellis a dense trichoderm of digitate, septate hyphae; terminal elements cylindrical, obtuse, often sinuous, 20–60 × 2.5–5 µm, occasionally thick-walled, arising from long chains of spherical to irregularly shaped cells, evenly brown in KOH, interior walls irregularly thickened and jagged; pileocystidia 25–60 × 3–6 µm, narrow cylindrical, obtuse to subcapitate, rare or absent; all elements SV–, encrustations highly acid resistant in basic fuchsin, dark purple, abundant. Stipitipellis a dense trichoderm similar to the suprapellis,

composed of long chains of cylindrical, spheroidal to irregularly shaped cells, terminated by brownish ellipsoid or pyriform cells, internal walls irregularly thickened; cystidia rare or absent.

Habit, habitat, and distribution – Solitary to widely scattered on root mats of *Dicymbe corymbosa*, uncommon; found May through early July during wet weather. Known only from the type locality in the Upper Potaro Basin of Guyana.

Additional specimens examined: **GUYANA. Region 8 Potaro–Sipiruni.** Pakaraima Mountains, Upper Potaro River Basin, within 5 km radius of Potaro base camp located at 5°18′04.8″N 59°54′40.4″W, 710–750 m. Near Ayanganna Airstrip, 20.V.2000, Miller 10039 (BRG, RMS). *Dicymbe* Research Plots, 27.V.2000, Miller 10070 (BRG, RMS). Vicinity of Potaro Base Camp, 31.V.2001, Aime 1724 (BRG, LSUM). ~3.5 km SE of base camp near *Dicymbe* plot 2, 12.VI.2001, Henkel 8270 (BRG; HSU); 19.V.2010 Aime 3974 (BRG, LSUM). Mixed Forest Research Plots MP1, 7.VII.2009, Henkel 9006 (BRG, HSU). Near Potaro Falls, 4.VII.2002, Aime 2196 (BRG, LSUM).

Commentary – This is an unusual *Russula* species whose initial encounter in the low-tech environment of field work in Guyana sparked a great deal of debate regarding generic placement. The combination of pilose pileus, strongly inrolled margin, somber yellowish brown to dull brown colors, and tendency for the lamellae and stipe to discolor brownish, was reminiscent of the temperate *Paxillus involutus*. However, close observation of the basidiospores in Melzer's reagent, even without a microscope, confirmed the amyloid reaction.

Molecular analysis (SL Miller, unpublished) places *R. paxilliformis* consistently near *R. matoubensis* Pegler. *Russula matoubensis* is a much brighter orange but also has a subtomentose (especially when collected fresh in dry conditions) pileus that becomes finely granular to areolate-disrupted and squamulose away from the disc, exposing the underlying and much lighter colored tissue beneath. Microscopically, both fungi also possess a trichodermial palisade in the pellis, composed of ascendant hyphae, rare dermatocystidia and interwoven hyphae in the subpellis that are heavily encrusted with material that is positively acid resistant in basic fuchsin. In both fungi, scalp sections of the pileus cuticle turn instantly dark brown in KOH. Also, both taxa contain subpellis cells with irregularly thickened cell walls and lamprocystidia in the hymenium.

Pegler & Fiard (1979) placed *R. matoubensis* in *R.* sect. *Decolorantinae* Meltzer & Zvara based on orange pigment, mild taste, white context that discolors grey, and the presence of dermatocystidia in the pellis. Singer et al. (1983) acknowledged possible placement in *R.* subsect. *Decolorantes* (= *Decolorantinae*) but, noting the close resemblance of the anatomical characters to those of *R. fistulosa* R. Heim, ultimately placed *R. matoubensis* into subsect. *Fistulosinae* R. Heim ex Sing. Indeed, our molecular analysis consistently supports *R. paxilliformis* and *R. matoubensis* as a sister group to a clade

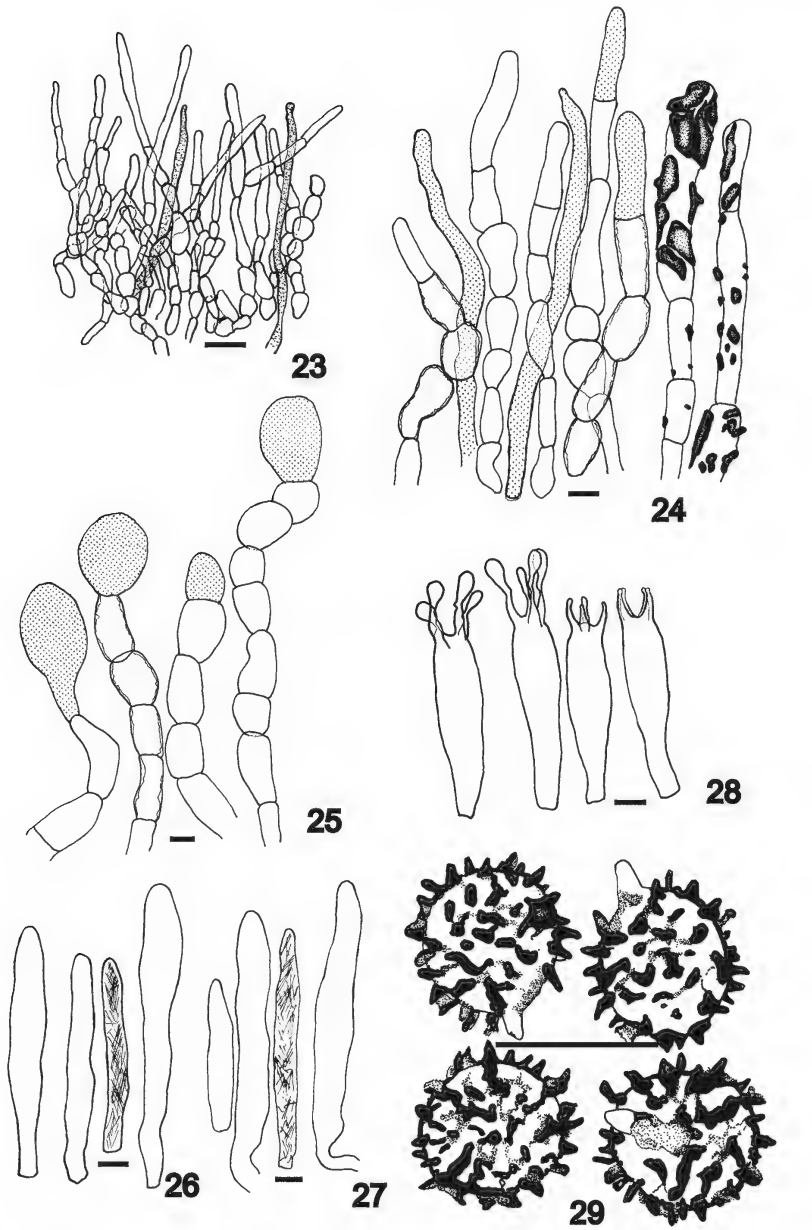

Plate 6. *Russula paxilliformis* (Miller 10097), microscopic features. 23. Diagram of a section of the dense trichoderm comprising the suprapellis. 24. Elements of the suprapellis showing long narrow pileocystidia, catenulate hyphae and acid resistant encrustations. 25. Elements of the stipitipellis. 26. Hymenial cystidia. 27. Marginal cells. 28. Basidia. 29. Basidiospores. Scale bars = 10 μm.

containing *R. ochraceorivulosa* Buyck, which Buyck (1994a) placed into subsect. *Pallidorimosinae* Buyck, and *R. patouillardii* Singer, which Buyck (1994b) placed into subsect. *Virescentinae* Singer. Morphologically, *R. paxilliformis* appears similar to members of the African subsections *Brunneofloccosinae* (e.g., *R. aurantiofloccosa* and *R. brunneofloccosa*) or *Testaceoaurantiacinae* (e.g., *R. testaceoaurantiaca* Beeli or *R. binganensis* Beeli), both described by Buyck (1990b). The features common to both the South American and African species are the abundant catenulate chains of spherical to cylindrical highly encrusted cells in the pellis, the pilose to velutinous pileus that develops a distinctive radial cracking pattern toward the margin, the basidiospores with fine connectives between amyloid ornamentation elements and frequently a large amyloid plage, and flesh or stipe surface that discolors brownish.

Russula gelatinivelata S.L. Mill., Aime & T.W. Henkel, **sp. nov.** PLATES 7–8

MYCOBANK MB 564267

Distincto gelatinoso partiali velo circa pileum et inferam partem stipitis juniorum, piloso rubrobrunneo pileo, et stipite cum rubra pilosa pagina in medio in distinctam areolatam ordinationem frangatur differt.

TYPE: Guyana, Pakaraima Mountains, Upper Ireng River Basin, east bank of Ireng River, 1 km downstream from Kurutuik Falls in *Dicymbe*-dominated slope forest, 15.V.1998, TW Henkel 6410 (**Holotype**, HSU; **isotype**, RMS, BRG; GenBank JQ405655).

ETYMOLOGY: *gelatinivelata* (Lat.), referring to the gelatinous partial veil evident in young, fresh specimens.

PILEUS 5.5 cm broad, convex at first, then broadly convex to slightly depressed; margin incurved at first, then decurved, entire when young, then frequently lacerate with age, obscurely striate when young, tuberculate striate when older, striations 6 mm in length; pellis dull to shiny, with a thick gelatinous partial veil present when young with material compacted into cavity formed by margin and stipe, subvelutinous in age, violet brown (11F7–8) with extreme margin cream (3A–2) when young, then reddish brown (9–10D–E–8) to brownish violet (11E6–7) or violet brown (10F–8), disk violet brown 10–11F6–8 or occasionally with pale yellow centrally, older specimens fading to grayish red (9C–D–5–6) with disk concolorous to violet brown (10F–8). LAMELLAE 3–3.5 mm broad at mid-radius, adnate to slightly sinuate to subdecurrent, close, frequently forking at stipe, entire, pale yellow (3A 2–3); lamellulae absent. STIPE 4.5 × 1.3 cm, equal or more typically tapered to base, attachment central, even to slightly irregular, viscid to gelatinous over lower one-half when young, becoming subtomentose above, conspicuously areolate below, with a white to cream (3A 2–3) zone at apex (I.E. concolorous with lamellae), rarely with a pinkish tinge, middle portions overlain with grayish- to brownish-red (10D 5–7) areolae frequently in a stretch-mark like pattern over a white or yellowish white (3A2) ground; the base concolorous with the apex or yellowish white

Plate 7. *Russula gelatinivelata* habit (Henkel 8233). 30. ×0.9.

(3A2). Context in pileus 2–3 mm at mid-radius pliant, white, pale pink immediately below cuticle, especially at disk; trama in stipe stuffed at maturity, outer cylinder pale yellow surrounding white central core; odor fragrant like Avon hand lotion; taste slightly bitter; $FeSO_4$ yellow on stipe surface, quickly salmon red on trama.

Basidiospores 6.8–7.6 × 6–6.8 (Q = 1.11–1.13), subglobose to broadly ellipsoid; ornamentation of widely distributed, isolated, acute, narrowly conical elements, 1.5(–2) µm high, amyloid, darkest near the apiculus; suprahilar plage large and verruculose, not or slightly decurrent on the apiculus. Basidia (24) 28–32(–36) × 8–13 µm, clavate to subcylindrical, 2-, 3-, or 4-spored, sterigmata long, 6.4–8 × 1–1.6 µm. Cystidia 75–130 × 15–18 µm, subclavate to cylindrical, obtuse to capitate, thin-walled, some long, arising deep within the lamella trama, others shorter, arising in hymenium, emergent 10–40 µm above basidia, scattered to numerous, SV–. Marginal cells 85–95 × 15–20 µm, fusiform, mucronate, strongly emergent, mixing with small basidia, numerous. Subhymenium well developed of small tightly packed spherical cells of 10 µm diam. Lamellar trama composed of many large sphaerocytes, and nests of relatively small, nearly isodiametrical to globose sphaerocytes, interwoven with cylindrical hyphae. Pileipellis orthochromatic in Cresyl Blue, two-layered; subpellis of slightly gelatinized interwoven hyphae of 4–5 µm diam intergrading with discrete regularly spaced rosettes, these often encrusted with reddish brown pigment in KOH; suprapellis a loose trichoderm composed of frequently branching spindly hyphae; these 5–12 µm diam, cylindrical to clavate, obtuse and often sinuous and irregularly constricted, often multi-septate, thin- or exceptionally thick-walled, arising from large

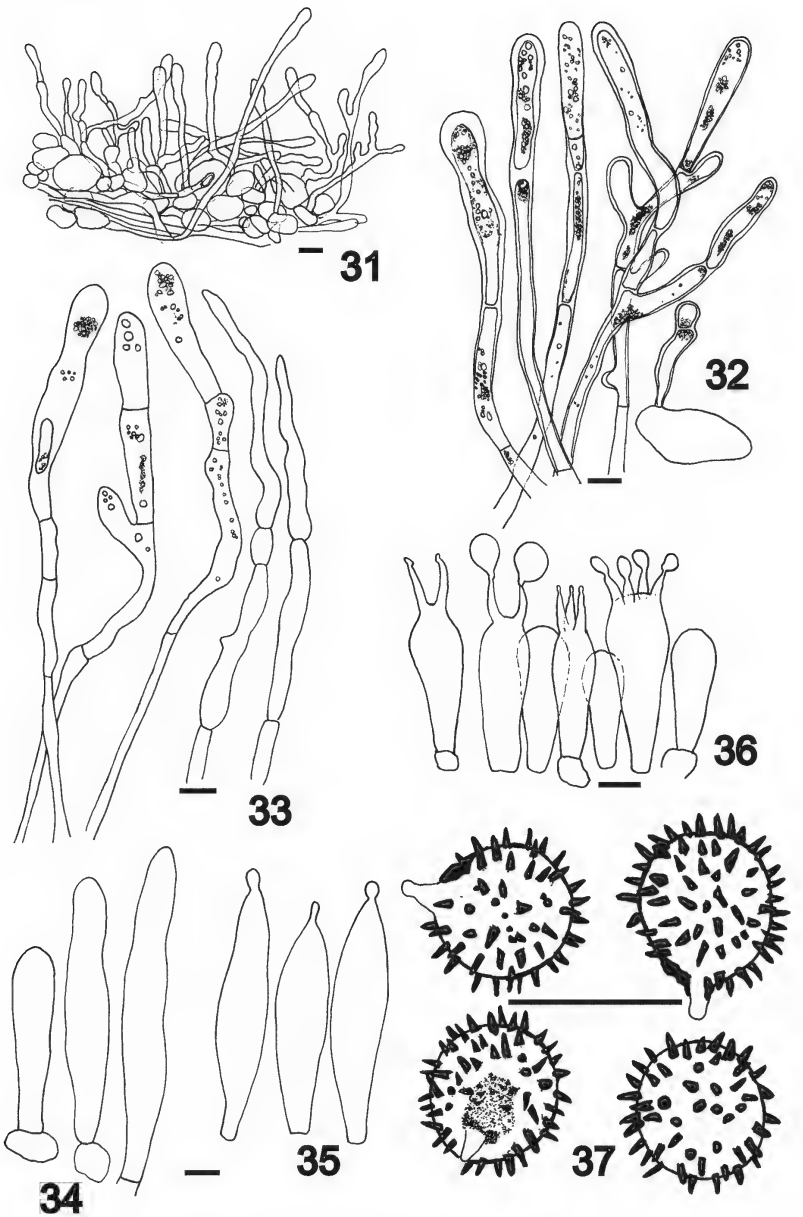

Plate 8. *Russula gelatinivelata* (Miller 10066), microscopic features. 31. Diagram of a section of the two-layered pileipellis; the suprapellis is a trichoderm over a thin pseudoparenchymatous subpellis. 32. Elements of the suprapellis. 33. Elements of the stipitipellis. 34. Hymenial cystidia. 35. Marginal Cells. 36. Basidia. 37. Basidiospores. Scale bars = 10 μm.

inflated spherical cells 2–6 deep that in aggregate resemble an epithelium; these easily disarticulated in microscopic preparations; cystidia 50–100 µm, long pedicellate, septate, irregularly constricted or swollen at the septum, thin- or thick-walled, arising deep in the trama, SV–, the contents or interior of the walls acid resistant in basic fuchsin. Stipitipellis resembling the pileipellis, composed of branching, septate, digitate to irregularly shaped hyphae that taper at the apex, and pedicellate, septate, thick-walled hyphae that are cylindrical, clavate, obtuse and irregularly constricted.

Habit, habitat, and distribution — Solitary to usually gregarious on root mats of *Dicymbe corymbosa*, or in stands of *Dicymbe altsonii* lacking *D. corymbosa*; common and widespread; found May through early July during wet weather. Known from the Upper Ireng and Upper Potaro Basins of Guyana.

Additional specimens examined: **GUYANA. Region 8 Potaro–Siparuni.** Pakaraima Mountains, Upper Ireng River Basin, elevation 710–850 m. Suruwabaru Creek, 1 km upstream of juncture with Yuarka Creek, in *Dicymbe*-dominated riparian forest, 2.III.1997, Henkel 6269 (BRG; HSU). East bank Ireng River near Sandhill Village, under *Dicymbe altsonii* in riparian forest, 1.V.1998, Henkel 6360 (BRG; HSU). East bank of Sukabi River, 1.5 km upstream from Juncture with Ireng River in *Dicymbe corymbosa*-dominated slope forest, 22.V.1998, Henkel 6441 (BRG; HSU). Toe slopes of Mt. Kukuinang, 3 km east of confluence of Sukabi and Ireng Rivers in *Dicymbe corymbosa*-dominated slope forest at 850 m elevation, 23.V.1998, Henkel 6550 (BRG; HSU). East bank of Ireng River near Sukabi camp, under *Dicymbe corymbosa*, 27.V.1998, Henkel 6638 (BRG; HSU). ~1 km east of confluence of Sukabi and Ireng Rivers, in slope forest dominated by *Dicymbe altsonii* lacking in *Dicymbe corymbosa*, 27.V.1998, Henkel 6750 (BRG; HSU). Pakaraima Mountains Upper Potaro River Basin, within 5 km radius of Potaro base camp located at 5°18′04.8″N 59°54′40.4″W, 710–750 m. Vicinity of Potaro Base Camp, 20.V.2000, Miller 10066 (BRG, RMS). *Dicymbe* stand on Benny's ridge near Potaro River camp, 11.VI.200, Miller 10125 (BRG, RMS). ~3.5 km SE of base camp near *Dicymbe* plot 2, 26.V.2010, Henkel 9226 (BRG; HSU). ~3 km SE of base camp in *Dicymbe* plot 1, 30.V.2001, Henkel 8233 (BRG; HSU). Vicinity of *Dicymbe* plot 3, 21.VI.2002, Aime 2096 (LSUM, HSU).

Commentary – Young basidiomata of *R. gelatinivelata* in moist conditions are encased in a thick gelatinous layer around the lower portion of the stipe and pileus that is present as a veil in the space between the stipe and inrolled pileus margin. The red tomentum and striped areolate patches in the middle portion of the stipe overlaying yellow ground are remarkable.

Molecular analysis (SL Miller, unpublished) indicates that *R. gelatinivelata* has a closer relationship with *Russula* temperate species than any other species collected in Guyana. Specifically there appears to be a consistent relationship with *R. nauseosa* (Pers.) Fr., *R. cessans* A. Pearson, and *R. laricina* Velen., or with *R. aurea* Pers. and *R. romellii* Maire, all temperate taxa that have large, abundant multiseptate cystidiate hyphal elements in the pellis. In *R. gelatinivelata* the walls of these elements, while not encrusted per se, are highly positive for acid resistant coloration in basic fuchsin. The temperate taxa appear to lack this

characteristic, although taxa that have been placed in closely related sections and subsections (e.g. section *Incrustatae* Romagn.) are also highly positive for acid resistant coloration in basic fuchsin, but this is expressed in the form of abundant encrustations on the exterior of the elements. *Russula gelatinivelata*, along with *R. nauseosa* and *R. laricina*, has spores with isolated elements, while *R. cessans*, *R. aurea*, and *R. romellii* have spores with at least a partial reticulum.

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Tuber in China: *T. sinopuberulum* and *T. vesicoperidium* spp. nov.

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Abstract — Two new species are described and illustrated. *Tuber sinopuberulum* is recognized by its glabrous peridium and globose to subglobose ascospores. *Tuber vesicoperidium* is distinguished by its peridial structure of large, thick-walled swollen cells. The two new species are supported by molecular studies.

Key words — *Ascomycota*, *Tuberaceae*, truffle

Introduction

The first species of *Tuber* P. Micheli ex F.H. Wigg. to be described in China was *T. taiyuanense* B. Liu in 1985 (Liu 1985, Cao et al. 2011). Of the additional 28 species since described, 19 appear endemic to China (Table 1). The other nine species (*T. aestivum* Vittad., *T. borchii* Vittad., *T. californicum* Harkn., *T. excavatum* Vittad., *T. indicum* Cooke & Massee, *T. lyonii* F.K. Butters, *T. maculatum* Vittad., *T. puberulum* Berk. & Broome, *T. rufum* Picco) have been recorded from India, Europe, or North America (Song 2005; Cao 2010). In recent years interest in Chinese *Tuber* species has accelerated partly because some are edible and are being marketed both at home and abroad. Marketplaces where locals sell their wild mushrooms have proven to be excellent places to find new species. Here we describe two new *Tuber* species, which we discovered in a Kunming (Yunnan Province, China) mushroom market where locals, including the Yi people (Wikipedia 2011), offer wild mushrooms for sale.

Materials & methods

Morphological studies

Truffles were collected from the mushroom market in Kunming, China on 20 December 2010. Specimens were deposited in BJTC (Herbarium of Biology Department, Capital Normal University). Fresh specimens were described both macro-

Table 1. *Tuber* species described from China since 1985

Species	Reference
T. sinense K. Tao & B. Liu	Tao et al. 1989
T. liaotongense Y. Wang	Wang, 1990
T. gigantosporum Y. Wang & Z.P. Li	Wang & Li 1991
T. formosanum H.T. Hu	Hu 1992 (from Taiwan)
T. pseudohimalayense G. Moreno et al.	Moreno et al. 1997
T. pseudoexcavatum Y. Wang et al.	Wang et al. 1998
T. liui A.S. Xu	Xu 1999
T. xizangense A.S. Xu	Xu 1999
T. huidongense Y. Wang	Wang & He 2002
T. zhongdianense X.Y. He et al.	He et al. 2004
T. furfuraceum H.T. Hu & Y. Wang	Hu & Wang 2005 (from Taiwan)
T. umbilicatum Juan Chen & P.G. Liu	Chen et al. 2006
T. latisporum Juan Chen & P.G. Liu	Chen et al. 2007
T. lijiangense L. Fan & J.Z. Cao	Fan et al. 2011
T. sinoexcavatum L. Fan & Yu Li	Fan et al. 2011
T. polyspermum L. Fan & C.L. Hou	Fan et al. 2012a
T. sinoalbidum L. Fan & J.Z. Cao	Fan et al. 2012a
T. microspermum L. Fan & J.Z. Cao	Fan et al. 2012b
T. microspiculatum L. Fan & Yu Li	Fan et al. 2012b

and microscopically. Razor-blade sections were mounted in 3% KOH or stained with Melzer's reagent, rinsed, and mounted in polyvinyl lactic glycerol to make permanent slides for archiving with dried specimens. For scanning electron microscopy (SEM), ascospores were scraped from the dried gleba onto double-sided tape mounted directly on an SEM stub, coated with gold-palladium, and examined and photographed with a HITACHI S-4800 SEM.

Molecular methods

Herbarium samples were crushed by shaking for 3 min at 30 Hz (Mixer Mill MM 301, Retsch, Haan, Germany) in a 1.5 ml tube with one 3 mm diameter tungsten carbide ball. Total genomic DNA was extracted using the PeqLab E.Z.N.A._Fungal DNA kit following the manufacturer's protocol. The ITS region was amplified with PCR using the primers ITS1/ITS4 (White et al. 1990). PCR was performed in 50 µl reactions containing DNA template 2 µl, primer (10 µM) 2 µl each, 2× Master Mix (Tiangen Biotech (Beijing) Co. Ltd.) 25 µl. PCR reactions were run as follows: an initial denaturation at 95 °C for 3 min, followed by 30 cycles at 95 °C for 2 min, 55 °C for 25 s, 72 °C for 2 min, and a final extension at 72 °C for 10 min. The PCR products were sent to Invitrogen Biotechnology Co. Ltd. (Beijing, China) for purifying, sequencing, and editing. Other ITS rDNA sequence data included in this study were downloaded from GenBank (Table 1).

Phylogenetic analyses

DNA sequences were aligned with Clustal X (Thompson et al. 1997). The alignment was manually adjusted with Se-Al v.2.03a (Rambaut 2000). The aligned dataset was analyzed with maximum parsimony (MP) using PAUP*4.0b10 (Swofford 2002). Maximum parsimony analysis was conducted using heuristic searches with 1000 replicates of random-addition sequence, tree bisection reconnection (TBR) branch

Table 2. *Tuber* specimens and sequence numbers used in molecular studies

Species	ITS	LSU
T. sinopuberulum (BJTC FAN157)	JQ690073	JQ690070
T. vesicoperidium (BJTC FAN155)	JQ690071	JQ690068
(BJTC FAN156)	JQ690072	JQ690069
T. borchii	HM485343	FJ809799
	HM485343	
	FJ809852	
T. californicum	DQ974799	AF127120
	HM485351	AF159627
	HM485346	
T. dryophilum Tul. & C. Tul.	HM485353	FJ809800
	HM485354	FJ809801
T. maculatum	EU784428	
	FM205649	
	AJ969627	
	AF106889	
T. oligospermum	FM205506	AY515306
	FM205507	
T. puberulum	AJ557536	
	AJ969625	
T. sphaerosporum Gilkey	FJ809853	FJ809805
	FJ809854	FJ809806
	HM485390	
T. zhongdianense	DQ898186	
	DQ898187	
T. panniferum Tul. & C. Tul.		FJ809845
		FJ809846
T. melanosporum Vittad.	AF132501	GU979139
	AF106878	FJ809819

swapping algorithm. All characters were equally weighted and unordered. Gaps were treated as missing data to minimize homology assumptions. A bootstrap (BS) analysis was performed with 1000 replicates, each with 10 random taxon addition sequences. TBR branch swapping was employed.

Results

Molecular phylogenetics

The maximum parsimony analysis of ITS sequences produced one most parsimonious tree (Fig. 1) with a length (TL) = 613 steps, consistency index (CI) = 0.7276, retention index (RI) = 0.8706, homoplasy index (HI) = 0.2724, and rescaled consistency index (RC) = 0.6335.

The maximum parsimony analysis of LSU sequences produced one most parsi-monious tree (Fig. 2) with a length (TL) = 380 steps, consistency index (CI) = 0.8816, retention index (RI) = 0.8308, homoplasy index (HI) = 0.2724, and rescaled consistency index (RC) = 0.7324.

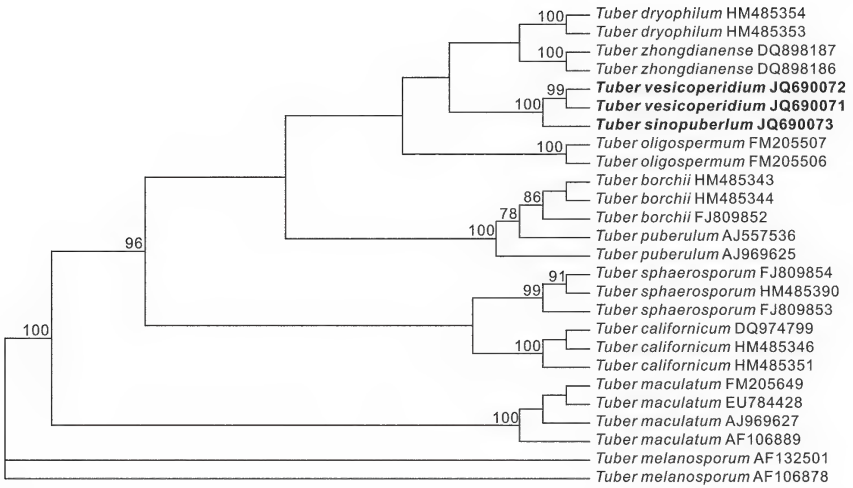

FIG. 1. Phylogeny derived from maximum parsimony analysis of the ITS rDNA sequences of some *Tuber* species with pale ascomata and reticulate ascospores, using *T. melanosporum* as outgroups. Bootstrap values of more than 70% from 1000 replications are shown above the respective branches.

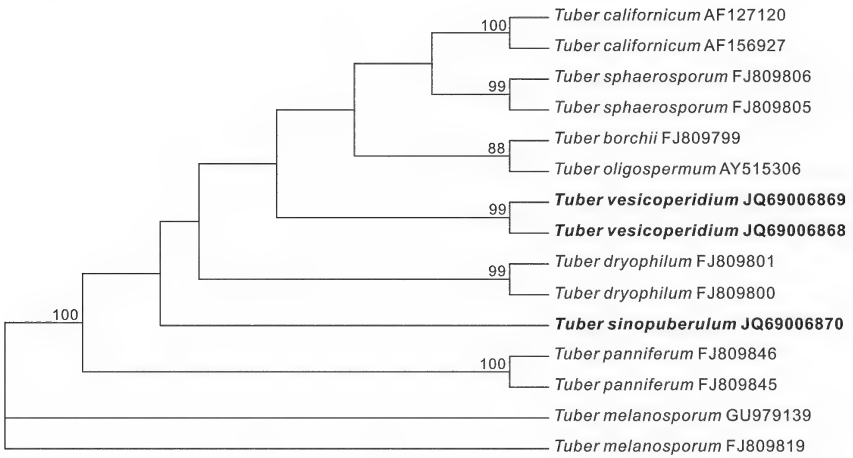

FIG. 2. Phylogeny derived from maximum parsimony analysis of LSU nuclear rDNA sequences of some *Tuber* species with pale ascomata and reticulate ascospores, additionally two sequences of *Tuber panniferum* with spiny ascospores, using *T. melanosporum* as outgroups. Bootstrap values of more than 70% from 1000 replications are shown above the respective branches.

The two new species, *Tuber sinopuberulum* and *T. vesicoperidium,* group into one clade with 100% bootstrap support in the ITS-based phylogenetic analyses (Fig. 1), but in the LSU-based analyses (Fig. 2), they separate into two distinct clades. Two *T. vesicoperidium* sequences group in a clade with strong bootstrap support (99% in both ITS and LSU sequence analyses). *Tuber sinopuberulum* and *T. vesicoperidium* have very similar ascomata and ascospores but very different peridial structures. *Tuber sinopuberulum* typically has a two-layered peridium composed of a pseudoparenchymatous layer and intricate textural layer, whereas *T. vesicoperidium* has a one-layered prosenchymatous peridium with very large and thick-walled swollen cells.

Taxonomy

Tuber sinopuberulum L. Fan & J.Z. Cao, **sp. nov.** Fig. 3

MycoBank MB 564482

Differs from *Tuber puberulum* by the absence of hyphae-like hairs on the peridium surface and by its globose to subglobose ascospores.

Type: China. Yunnan Province, Kunming, from the local mushroom market, 20 Dec. 2010, Jin-zhong Cao 120 (**Holotype**, BJTC FAN157).

Etymology: *sinopuberulum* (Lat.), referring to the similarity to the European species, *Tuber puberulum*.

Ascomata 2 × 2.5 cm, subglobose or lobed, firm, solid, surface smooth, glabrous, yellow white to light brown at maturity. Odor slight, not pungent. Peridium 250–350 μm thick, two layers; outer layer 80–120 μm thick, pseudoparenchymatous, composed of subangular or subglobose cells 7.5–20 μm in diam., with thin or slightly thickened walls, pale yellowish, no distinct hyphae-like hairs arising from the outermost cells; inner layer composed of intricately interwoven hyphae, hyaline, thin-walled, branch, septate, 3–5 μm in diam. Gleba light brown to brown at maturity, marbled with large and rare, branched white veins continuous with inner peridium. Asci subglobose, ellipsoid or irregular, hyaline, thin-walled, 70–110 × 65–100 μm, sessile or short stalk, 1–5 spored. Ascospores mostly globose or subglobose, a few broad ellipsoid, yellow-brown at maturity, 20–37.5 × 20–32.5 μm excluding ornamentation; ornamentation regularly alveolate reticulum, 2.5–4 μm high, the meshes generally 5–10 across the spore width.

Comments — *Tuber puberulum* from Europe is similar to this new species but can be easily differentiated by the 100–150 μm long hyphal-like hairs densely coating the peridial surface (Lange, 1956; Pegler et al. 1993) and ascospores that are not regularly globose.

The European *Tuber oligospermum* (Tul. & C. Tul.) Trappe and the American *T. californicum* might be confused because of their globose ascospores. However,

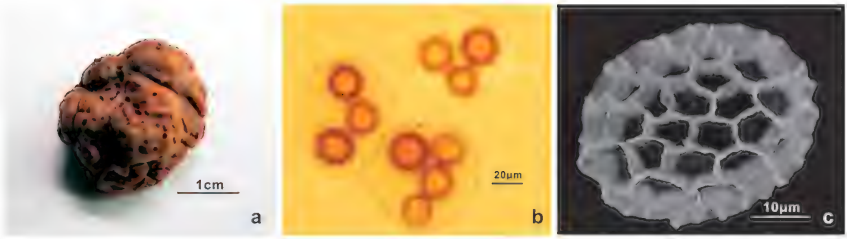

FIG. 3. *Tuber sinopuberulum* (BJTC FAN157, holotype) a. Ascoma. b. Asci and ascospores observed under light microscope. c. Ascospore observed under SEM.

T. oligospermum is distinguished by a one-layered peridium, and *T. californicum* can be separated by its dark colored gleba and puberulent ascomata.

Tuber vesicoperidium (described below) has ascospores similar to *T. sinopuberulum* but can be easily differentiated by its peridial structure characterized by very large and thick-walled swollen cells. The phylogenetic analyses (FIGS. 1–2) also show that while *T. sinopuberulum* groups in a clade with *T. vesicoperidium* in the ITS sequence analysis (FIG. 1), they are widely separated in two different clades in the LSU analysis (FIG. 2), suggesting that they are closely related but distinct species.

Tuber vesicoperidium L. Fan, **sp. nov.** FIG. 4

MYCOBANK MB 564483

Differs from all other *Tuber* species with globose or subglobose ascospores by its one-layered peridium of predominantly large, thick-walled, swollen cells.

TYPE: China. Yunnan Province, Kunming, from the local mushroom market, 20 Dec 2010, Jin-zhong Cao 118 (**Holotype,** BJTC FAN155).

ETYMOLOGY: *vesicoperidium* (Lat.), referring to the peridium with larger sized swollen cells.

ASCOMATA 2–4 cm, subglobose or lobed, a few of slight furrows, firm, solid, surface smooth, glabrous, white to pale yellow, light brown at maturity. Odor slight, not pungent. PERIDIUM 550–650 μm thick, one layer, prosenchymatous, composed of intricately interwoven hyphae, hyaline, thin-walled, branched, septate, 3–7.5 μm in diam., distinctly intermixed with large swollen cells of mostly ellipsoid-shape 50–130 μm in diam. with wall 5–7.5 μm thick, towards the inner side of the peridium, the number of the swollen cells less, integrating with the interwoven hyphae only, more or less parallel to the surface; no distinct hyphae-like hairs arising from the outermost cells. GLEBA grey brown to dark brown at maturity, marbled with large and rare, branched, white veins continuous with peridium. ASCI subglobose, ellipsoid or irregular, hyaline, thin-walled, 65–95 × 50–70 μm, sessile, 1–5 spored. ASCOSPORES mostly globose, a few subglobose, yellow-brown at maturity, 20–35.5 × 20–32.5 μm in 2–5 spored asci and 37.5–45 × 37.5–42.5 μm in 1-spored asci excluding ornamentation;

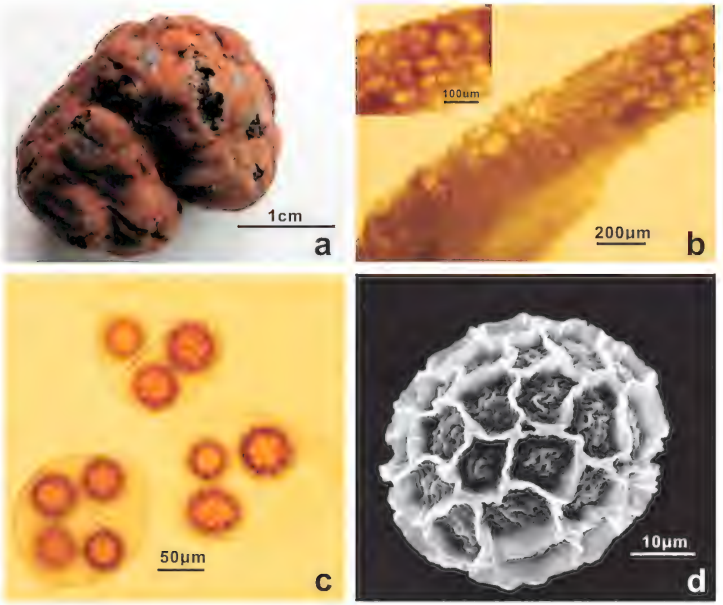

FIG. 4. *Tuber vesicoperidium* (BJTC FAN155, holotype) a. Ascoma. b. Peridium with the large, thick-walled swollen cells. c. Asci and ascospores observed under light microscope. d. Ascospore observed under SEM.

ornamentation regularly alveolate, 2.5–4 μm high, the meshes generally (2–) 3–6(–8) across the spore width.

ADDITIONAL SPECIMEN EXAMINED: **CHINA. YUNNAN PROVINCE**, Kunming, from the local mushroom market, 20 Dec 2010, Jin-zhong Cao 119 (BJTC FAN156).

COMMENTS — *Tuber vesicoperidium* is characterized mainly by its one-layered peridium and the large, thick-walled, swollen cells occupying nearly all the peridial tissue, thereby distinguishing it from all other known *Tuber* species with globose or subglobose ascospores. Large swollen cells also occur in some *Tuber* species with a two-layer peridium and spiny-reticulate ascospores, such as *T. borchii*, *T. zhongdianense*, and *T. malacodermum* E. Fisch., but with the swollen cells confined to the outer peridium. Lange (1956), Pegler et al. (1993), and Chen & Liu (2007) note that the shape and wall thickness of the swollen cells do not differ greatly from the surrounding cells and they do not normally exceed 70 μm in diam.

ITS (FIG. 1) and LSU (FIG. 2) sequence analyses group the *T. vesicoperidium* sequences in a clade with strong support (BP 99 for both analyses), supporting *T. vesicoperidium* as a distinct species. In the ITS sequence analysis (FIG. 1), the two *T. vesicoperidium* sequences group together with *T. sinopuberulum* with strong support (BP 100). This close relationship is reflected by their very similar

ascomata and ascospores, but the completely different peridial structures also indicate that the two taxa are morphologically independent.

Acknowledgments

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Presence of *Leucocoprinus cretaceus* and *L. fragilissimus* in Argentina

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Abstract — *Leucocoprinus cretaceus* and *L. fragilissimus* are recorded for the first time in Argentina. These species are described and illustrated, and a key to the Argentinean species of this genus is presented.

Key words — *Agaricomycetes, Agaricales, Agaricaceae*, *Leucocoprineae*, taxonomy

Introduction

Leucocoprinus Pat. was considered by Singer (1986) to belong to the tribe *Leucocoprineae* Singer in the family *Agaricaceae* Chevall. The genus is characterized by a pluteoid habit, convex to umbonate pileus with floccose pulverulent squamules, a striate-sulcate margin, a very thin context, free lamellae, and the absence of colour changes with ammonia vapour, a central stipe with bulbous-clavate base and annulus, and a white to pale pink spore-print. The basidiospores are smooth, hyaline, thick-walled, with or without an evident germ pore, dextrinoid, metachromatic in cresyl blue, basidia are 4-sterigmate, pleurocystidia are either absent or not numerous, and cheilocystidia are usually abundant. The pileipellis is very variable, formed by a mixture of different types of cells and hyphae, and generally is a disrupted epicutis mixed with sphaerocysts or chains of branched/unbranched inflated hyphae that sometimes form erect, loose fascicles comprising the squamules. The hymenophoral trama is regular and trabecular and clamp connections are absent. *Leucocoprinus* species are solitary to gregarious, terrestrial, and saprotrophic (Singer 1986, Vellinga 2001, Gimenes 2007, Rother & Borges da Silveira 2009). The most similar genus, *Leucoagaricus* Locq. ex Singer, differs

mainly by lacking a long striate-sulcate pileal margin, having a thinner context, and lacking pseudoparaphyses (Pegler 1983, Singer 1986, Vellinga 2001).

Leucocoprinus has a pantropical distribution and is also found growing in greenhouses of temperate regions (as introduced species) (Vellinga 2004). The genus comprises approximately 40 species worldwide (Kirk et al. 2008). In Argentina the specific diversity of this genus is poorly known. Only six species and two infraspecific varieties have been recorded so far (Raithelhuber 1974, 1987a–c, 1988, 1991, 2004; Singer & Digilio 1952, Spegazzini 1898, 1926; Wright & Albertó 2002).

This paper resulted from research into the diversity of *Agaricales* from the rainforests in northern Argentina. The Atlantic Forest, which stretches along the Atlantic coast of Brazil with its southern border reaching eastern Paraguay and northeastern Argentina, is one of the most threatened tropical-subtropical rainforests in the world (Placi & Di Bitetti 2006) and regarded as one of the 25 biodiversity hotspots for conservation (Myers et al. 2000). The aim of this paper is to report the results of the study of recent collections of *Leucocoprinus* from this habitat.

Materials & methods

The authors recently collected the specimens in protected areas from northern Argentina. The specimens were macroscopically described according to Largent (1986) and Lodge et al. (2004). Color names are in accordance with Kornerup & Wanscher (1978). Microscopic features are described from material mounted in 5% KOH and phloxine (1%). Meltzer's reagent, cresyl blue, and cotton blue were used to determine whether the spores were dextrinoid, metachromatic, and cyanophilic, respectively. Dimensions were recorded from 20 basidiospores per collection. Standard deviation, quotient of length/width (Q), and average Q-value (Qm) were calculated for each species from all spores measured (n). Herbarium abbreviations follow Index Herbariorum (Thiers 2011). Complete synonymies are not presented; for a complete list see Vellinga (2010). The collections are deposited in CTES Mycological Herbarium.

Taxonomy

Leucocoprinus cretaceus (Bull.) Locq., Bull. Mens. Soc. Linn. 14: 93 (1945). FIGS 1–5

≡ *Agaricus cretaceus* Bull., Herb. Fr. 8: tab. 374 (1788).

PILEUS 27–75 mm diam., at first ovoid then convex to broadly conical, umbonate in maturity, white (1.A1), covered by easily removed, granular floccose, white squamules, conical to pyramidal on the umbo; margin entire, sulcate. LAMELLAE white, crowded, free, membranous, 2–4 mm wide, with lamellulae; margin entire. STIPE 50–90 × 3–7 mm, central, cylindrical, becoming inflated fusoid towards the base, 15–30 × 8–15 mm, white, glabrescent, fistulose, with a covering of floccose squamules from the base to the annulus. ANNULUS present, attached to the upper part of the stipe, simple, membranous, white,

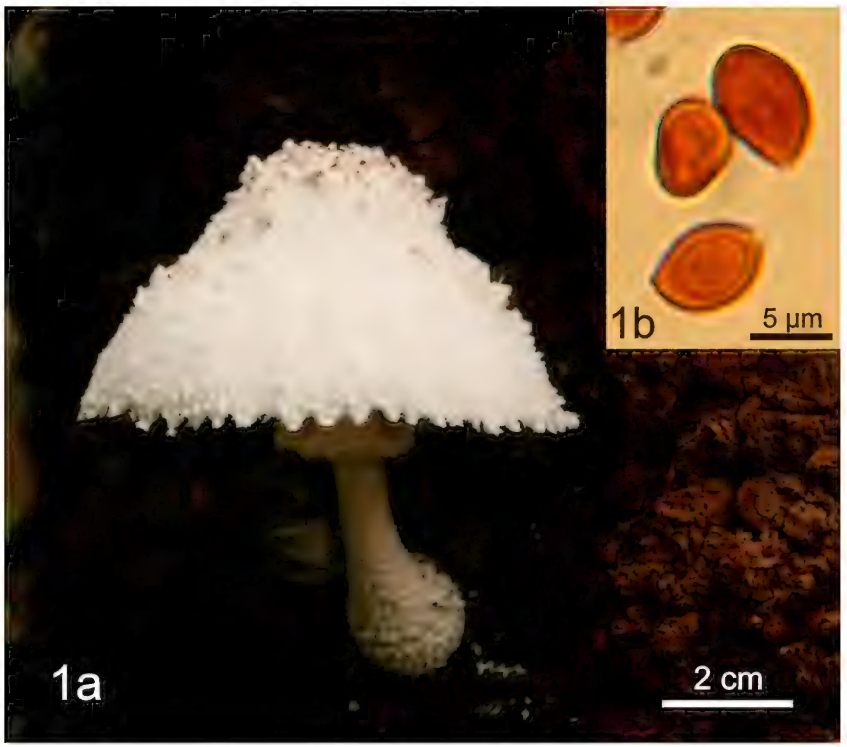
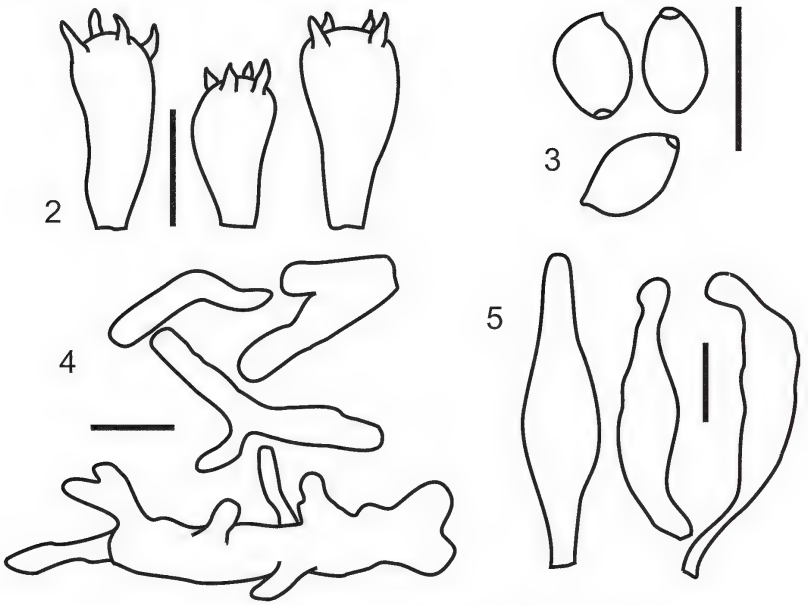


Fig. 1: *Leucocoprinus cretaceus* (Niveiro & Michlig 1614 CTES)
a: general aspect; b: spores in Meltzer's reagent.

evanescent. Context white, thin. Spore print white.

Basidiospores 6.8–10 × 5–6.6 µm (8.5 ± 0.8 × 5.7 ± 0.4 µm); Q = 1.2–1.7 µm; Qm = 1.5, n = 60, ellipsoid, hyaline, smooth, thick-walled, walls 0.6–0.7 µm, with an obvious germ pore, dextrinoid, metachromatic, cyanophilic. Basidia 18–30 × 7–11 µm, claviform, with 4 sterigmata. Pseudoparaphyses 11–18 × 6–10 µm, claviform. Pleurocystidia absent. Cheilocystidia 38.3–46.6 × 8–16(–20) µm, narrowly clavate, lageniform to ventricose, thin-walled, hyaline. Hymenophoral trama regular, hyphae 3.6–8 µm, with smooth, thin walls; inamyloid. Pileipellis made up of hyaline hyphae with smooth walls and cylindric terminal elements with excrescences, branched in different shapes (H, T and Y), 24–45 × 7.5–15 µm. Stipitipellis a cutis of narrowly cylindrical, 2–7 µm broad hyphae. Clamp connections absent.

Habitat (of Argentinean collections) — Solitary or gregarious. On bark of living gymnosperms (*Araucaria angustifolia*) and unidentified dicotyledonous trees in subtropical forest.



Figs 2–5: *Leucocoprinus cretaceus* (Niveiro & Michlig 1614 CTES)
2: basidia; 3: spores; 4: pileipellis; 5: cheilocystidia. Scale bar = 10 µm.

Material examined — **ARGENTINA, Corrientes:** Dpto. Mburucuyá, Mburucuyá National Park, "Che Roga" trail, 6/IV/2007, leg. Niveiro & Michlig 441 (CTES); Santa Teresa Ranch, 7/IV/2007, leg. Niveiro & Michlig 480 (CTES). **Misiones:** Dpto. Gral. Belgrano, San Antonio Natural Reserve, on *Araucaria angustifolia*, 26°02′14.2″S 55°47′24.8″W, 526 m, 29/V/2009, leg. Niveiro & Michlig 1614 (CTES).

Distribution — *Leucoagaricus cretaceus* is distributed in tropical regions and adjacent temperate regions in North America and Europe (Vellinga 2001, Birkebak 2010). It has been recorded from Africa, Asia, Europe, North America, and South America (Brazil: Gimenes 2007, Meijer 2006, Rother & Borges da Silveira 2009, Sobestiansky 2005, Wartchow et al. 2008). This is the first record of *L. cretaceus* in Argentina (Misiones and Corrientes Provinces).

Comments — *Leucocoprinus cretaceus* is easily recognized by its fleshy white basidiomata covered by floccose squamules that are easily removed when touched and by a fusoid stipe inflated toward the base. This species is related to *L. squamulosus* (Mont.) Pegler from Guyana and Lesser Antilles with similar basidiospores but which lacks an annulus and an inflated stipe base (Pegler 1983, Dennis 1952, Wartchow et al. 2008).

Dennis (1952, 1970) and Pegler (1977, 1983, 1986) identified tropical species with a white basidioma and pileus covered by concolorous floccose

squamules as *Leucocoprinus cepistipes* (Sowerby) Pat. However, Candusso & Lanzoni (1990) and Vellinga (2001) considered *L. cepistipes* a separate species based on the ochraceus to pale brown squamules covering the pileus surface (Candusso & Lanzoni 1990, Wartchow et al. 2008, Gimenes 2007). Vellinga (2001), Gimenes (2007), and Rother & Borges da Silveira (2009) explain these conflicting species concepts.

Leucocoprinus fragilissimus (Ravenel ex Berk. & M.A. Curtis) Pat., Essai Tax. Hyménomyc.: 171 (1900). Figs 6–8

≡ *Hiatula fragilissima* Ravenel ex Berk. & M.A. Curtis, Ann. Mag. Nat. Hist., Ser. 2, 12: 422 (1853).

Pileus 20–44 mm diam., conic-campanulate, becoming plane with a small umbo, even depressed, sulcate-striate to the umbo, white to slightly yellowish (1.A1–1.A3) when young, becoming whitish and almost translucent except for a central disk in maturity, umbo pale yellowish-brown (1.A4) with small yellow squamules, dry. Lamellae white, thin, subdistant, free, with lamellulae; margin entire. Stipe 60–100 × 1–2 mm, equal, fragile, central, light yellow (1.A5), with scattered small yellowish squamules, fistulose. Annulus present, white, small, membranous, movable, evanescent, attached to the upper to middle part of the stipe. Context white, very thin, almost absent, except at the disk, membranous, subdeliquescent. Spore print off-white.

Basidiospores 9–12.7 × 6.5–10 µm (11.1 ± 0.8 × 8.1 ± 0.6 µm); Q = 1.1–1.6; Qm = 1.4, n = 54, broadly ellipsoid to subglobose, smooth, hyaline, thick-walled, with an obvious germ pore with a hyaline dome, dextrinoid, metachromatic, cyanophilic. Hymenial elements not observed. Pleurocystidia and Cheilocystidia unobserved. Pileipellis an epithelium with hyaline, globose, more or less isodiametric elements, 17.2–25.3 µm in diameter, thin-walled, mixed with hyaline, thin, more or less cylindrical hyphae. Stipitipellis a cutis of narrowly cylindrical, 5–12 µm broad hyphae. Clamp connections absent.

Habitat (of Argentinean collections) — Solitary or gregarious in small groups. On decomposing dicotyledonous wood and in soil among litter in subtropical pastures and forests.

Material examined — **ARGENTINA, Corrientes**: Dpto. Mburucuyá, Mburucuyá National Park, 7/IV/2007, leg. Niveiro & Michlig 448 (CTES); 8/IV/2007, Santa María Ranch, leg. Niveiro & Michlig 496 (CTES). **Misiones**: Dpto. Gral. Belgrano, San António Natural Reserve, 26°01′41.4″S 53°47′20.8″W, 322 m, 28/V/2009, leg. Niveiro & Michlig 1477 (CTES); Dpto. San Pedro, Moconá Provincial Park, 27°09′25.0″S 53°54′07.9″W, 289 m, 25/V/2009, leg. Niveiro & Michlig 1356 (CTES).

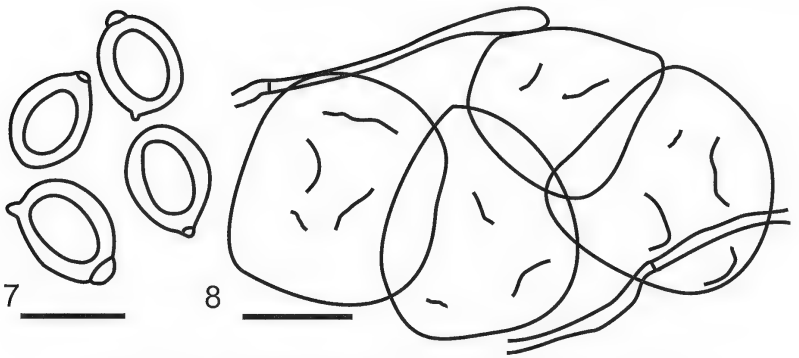
Distribution — *Leucocoprinus fragilissimus* has a pantropical distribution (Pegler 1983). It has been recorded from Africa, Asia, Europe, North America, and South America (Ecuador: Reid et al. 1981; Brazil: Albuquerque et al. 2006, Capelari & Maziero 1988, Gimenes 2007, Pegler 1997, Rother & Borges da

Fig. 6: *Leucocoprinus fragilissimus* (Niveiro & Michlig 1356 CTES)
a: general aspect; b: spores in Meltzer's reagent.

Silveira 2009, Wartchow et al. 2008). This is the first record of this species in Argentina (Misiones and Corrientes Provinces).

Comments — *Leucocoprinus fragilissimus* is widely distributed in the tropics and subtropics (Halling & Mueller 2005). It is characterized by subdeliquescent basidiomata and a membranous, yellowish-white pileus with small yellow squamules (Pegler 1983, Rother & Borges da Silveira 2009). Although the hymenial elements were not observed in our collections due to the subdeliquescent pileus, the basidiospore shape and size and pileipellis structure completely agree with those of this species.

According to Pegler (1983) and Smith & Weber (1982), *L. fragilissimus* is probably a common pantropical species but rarely collected owing to the extremely delicate basidiomata, which make field collection difficult. The presence of cheilocystidia in this species is rarely mentioned. According to Smith & Weber (1982), the cheilocystidia are 13–25(–36) × 9–15(–20) µm in size.



Figs 7–8: *Leucocoprinus fragilissimus* (Niveiro & Michlig 1356 CTES)
7: spores; 8: pileipellis. Scale bar = 10 µm.

Leucocoprinus tenellus Pegler [nom. illegit., non (Boud.) Locq.] from the Lesser Antilles and *L. thoenii* Heinem. from Zaire are also species with thin fragile basidiomata. Their habit and spore shape also resemble *L. fragilissimus*, but *L. tenellus* and *L. thoenii* differ in the absence of any yellow pigments (Pegler 1983). *Leucocoprinus brunneoluteus* Capelari & Gimenes from Brazil also has fragile basidiomata but differs from *L. fragilissimus* in its more yellowish coloration and the presence of brown umbo and squamules (Capelari & Gimenes 2004, Rother & Borges da Silveira 2009).

Key to species of *Leucocoprinus* in Argentina

1a. Basidiomata yellow or yellowish-white 2
1b. Basidiomata white, brownish to pinkish-orange (i.e. non yellowish) 4

2a. Pileus extremely thin and subdeliquescent, white with bright yellow small adpressed squamules ..... *L. fragilissimus*
2b. Pileus fleshy, pale yellow to sulphur yellow, covered by loose, scattered, floccose squamules 3

3a. Pileipellis made up of elongated elements; spores 7–10 × 5–7 µm, with an obvious germ pore ..... *L. birnbaumii*
3b. Pileipellis made up of globose elements; spores 5–7.5 × 3–5 µm, without an obvious germ pore ..... *L. straminellus*

4a. Pileus pinkish-orange; stipe with reddish, greenish, or bluish tinges; spores 3.5–4.5 µm broad. ..... *L. fibrillosus*
4b. Pileus white to yellowish-brown, pale brown or greyish; stipe whitish, without reddish, greenish or bluish tinges; spores 5–8 µm in broad. 5

5a. Pileus 15–25 mm in diam., hemispheric to convex, pale brown with a darker center. ..... *L. acer*
5b. Pileus 20–75 mm diam., conic-convex, campanulate, umbonate in maturity, white, greyish to yellowish-brown 6

6a. Pileus covered by ochraceus squamules, darker in the center; stipe greyish white to yellowish, smooth or covered by scattered squamules ..... *L. cepistipes*

6b. Pileus covered by white, floccose squamules; stipe covered by white floccose squamules from the annulus to the base ..... *L. cretaceus*

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Two new species of *Lasionectria* (*Bionectriaceae, Hypocreales*) from Guadeloupe and Martinique (French West Indies)

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Abstract —*Lasionectria marigotensis* sp. nov. on decaying leaves of *Cocos nucifera* (*Arecaceae*) in Guadeloupe and *L. martinicensis* sp. nov. on dead stems of *Passiflora* sp. (*Passifloraceae*) in Martinique are described and illustrated. The acremonium-like asexual state was obtained in culture for both species. An updated key to the species of *Lasionectria* is provided.

Key words —*Ascomycota*, neotropics, palm fungi, taxonomy

Introduction

The genus *Lasionectria* (Sacc.) Cooke is based on the lectotype *L. mantuana* (Sacc.) Cooke, designated by Clements & Shear (1931). The ascomata of *Lasionectria* are yellow, pale orange, red-orange or dark brown, and do not obviously change colour in 3% KOH or lactic acid; thus *Lasionectria* belongs to the *Bionectriaceae* Samuels & Rossman as defined by Rossman et al. (1999). The genus is distinguished from other genera in the *Bionectriaceae* by the ascomatal wall over 20 µm thick and composed of thick-walled cells with a small lumen and hairs scattered over the ascomatal surface. Hairs may be stiff or flexuous, solitary or fasciculate but do not form a distinct apical crown. The most similar genus is *Ijuhya* Starbäck, which differs mainly in having ascomata with a wall less than 20 µm thick and typically with a discoid flattened apex fringed by triangular fascicles of hairs, or rarely without hairs (Rossman et al. 1999). Both genera have acremonium-like anamorphs in culture and occur on various woody or herbaceous substrates.

In the course of an ongoing research program on the fungal diversity of Lesser Antilles, «Les champignons des Petites Antilles; diversité, écologie, protection», conducted by Prof. R. Courtecuisse (Courtecuisse 2006), two bionectriaceous ascomycetes were collected that permitted a detailed

morphological characterization and successful single ascospore isolations. Based on perithecia not changing color in 3% KOH or lactic acid, ascomatal wall composed of two regions with the outer region composed of thick-walled cells with a small lumen, presence of hairs on the surface and comparison with known species in the genus, these specimens were determined to represent previously undescribed species of *Lasionectria*. Both specimens were cultured from single ascospores and produced acremonium-like asexual state.

Materials & methods

Specimens were examined using the methods described by Rossman et al. (1999). Microscopic observations and measurements were made in water and the ascospore ornamentation was observed in cotton blue in lactic acid. Cultures were made from single ascospores that were isolated on PDA (Difco™ Potato Dextrose Agar). The holotype specimens are deposited in LIP herbarium (Lille) and cultures at CBS.

Taxonomy

Lasionectria marigotensis Lechat & J. Fourn., **sp. nov.** PLATE 1a–f

MYCOBANK MB 564150

Differs from known *Lasionectria* species in white to pale orange ascomata with erect non-fasciculate hairs evenly scattered on surface and relatively small, smooth-walled ascospores.

TYPE: French West Indies, Guadeloupe, Vieux Habitants, Marigot, l'Anse à la barque, on decaying leaf of *Cocos nucifera* L. (*Arecaceae*), 3 Aug. 2011, leg. Christian Lechat CLLGUAD11002 (**Holotype**, LIP; ex-type culture CBS131606).

ETYMOLOGY: The epithet is derived from Marigot, the locality where this species was collected.

PERITHECIA gregarious, superficial, subglobose, (130–)160–180(–200) µm high × (120–)130–150(–180) µm diam. (^{m} = 170 × 145 µm, n = 10), white to pale orange, collapsing cupulate, shining when dry, not changing color in 3% KOH or lactic acid, hairs erect to flexuous covering perithecial surface. PERITHECIAL APEX conical, composed of a palisade of cylindrical cells rounded at tip. HAIRS 14–47 µm long, 3–3.5(–4) µm wide, hyaline, cylindrical, thick-walled (1 µm), rounded at tip, aseptate. PERITHECIAL WALL 20–25(–30) µm thick, composed of two regions: outer region 15–20 µm wide, of globose to ellipsoidal 2.5–7 × 2–4.5 µm cells, with pale yellow walls 1–1.5 µm thick, each with a small lumen; inner region 5–10 µm wide, of elongate, flattened cells 4–11 × 1.5–2.5 µm, with hyaline walls 0.5–0.8 µm thick. ASCI evanescent (30–)40–48(–53) × (7–)8–9(–10) µm (^{m} = 44.5 × 8.7 µm, n=20), clavate, apices flattened, without ring, with eight biseriate ascospores completely filling each ascus. ASCOSPORES (9–)10–12.5(–13.5) × 3–3.5µm (^{m} = 11.6 × 3.2 µm, n=30), fusiform, slightly curved, 1-septate, hyaline, smooth.

Plate 1. ***Lasionectria marigotensis*** (holotype). **a.** Perithecia. **b.** Hairs. **c.** Culture. **d.** Perithecium in water. **e.** Ascospores. **f.** Median section of perithecial wall. ***Lasionectria martinicensis*** (holotype). **g–h.** Perithecium. **i.** Ascus and ascospores. **j.** Median section of perithecial wall. **k.** Striations dehiscing from the ascospores. **l.** Culture. Scale bars: a, g, h = 100 µm; b = 30 µm; d = 50 µm; e, i, k = 10 µm; f, j = 20 µm.

In Culture: After three weeks at 25°C on Difco PDA containing 5 mg/L streptomycin, colony 5–7.5 cm diam, without coloration of the medium, mycelium white to greyish, producing an *Acremonium*-like anamorph at white margin of colony, conidiophores monophialidic, 18–34 µm long, 2–2.5 µm diam with 1-septum at base, finely spinulose, arising from smooth hyphae 2–2.8 µm diam, conidia cylindrical to widely ellipsoidal (3.5–)4–6(–6.5) × 2–2.8 µm (^{m} = 5.4 × 2.5 µm, n = 30), hyaline, smooth, non-septate, with a basal abscission scar.

Lasionectria martinicensis Lechat & J. Fourn., **sp. nov.** Plate 1g–l

MycoBank MB 563442

Differs from known *Lasionectria* species in pale orange ascomata with erect non-fasciculate hairs evenly scattered on upper half and striate ascospores.

Type: French West Indies, Martinique, Schoelcher, Rivière Case Navire, on dead stems of *Passiflora* sp. (*Passifloraceae*), 28 Aug. 2010, leg. Christian Lechat CLLMAR085 (**Holotype**, LIP; ex-type culture CBS129746).

Etymology: The epithet is derived from the name of the island where this species was collected.

Perithecia solitary, superficial, subglobose to obpyriform, (200–)220–270 (–285) µm high × (160–)180–250(–270) µm diam. (^{m} = 250 × 220 µm, n = 10), pale orange to orange, collapsing laterally, not changing color in 3% KOH or lactic acid, hairs erect scattered over the upper half of the perithecium. Perithecial apex conical composed of palisades of cylindrical to narrowly clavate cells. Hairs 40–75 µm long, 6–7 µm wide at base, attenuated at tip, hyaline, cylindrical, thick-walled (1–1.7 µm), rounded or acute at tip, septate. Perithecial wall 25–35 µm thick, composed of two regions: outer region 15–20 µm wide, of globose to ellipsoidal 3.5–7 × 2–6 µm cells, with pale yellow walls 1.2–1.7 µm thick, each with a small lumen; inner region 8–15 µm wide, of elongate, flattened cells 8–19 × 2.5–3.5 µm, with hyaline walls 0.5–1 µm thick. Asci (65–)70–75(–80) × (8–)9–11(–12) µm (^{m} = 72.5 × 10.5 µm, n = 20), clavate, apices rounded, without ring, with eight biseriate ascospores. Ascospores (14–)16–20(–22) × 3–3.7µm (^{m} = 18.9 × 3.4 µm, n = 30), fusiform, 1-septate, hyaline, striate with striations finely verrucose and dehiscing from ascospore when slightly crushed under the cover slip.

In Culture: After two weeks at 25°C on Difco PDA containing 5mg/L streptomycin, colony 3–3.5 cm diam, spreading a reddish brown coloration in medium, mycelium white to pale yellow, producing an *Acremonium*-like anamorph at margin of colony, conidiophores monophialidic, 42–55 µm long, 3–4 µm diam with 1-septum at base, arising from smooth hyphae 2.5–3.8 µm diam, conidia cylindrical to widely ellipsoidal (3.5–)4–6.5(–7) × 2– 4 µm (^{m} = 6.1 × 3.2 µm, n = 30), hyaline, smooth, non-septate, with a basal abscission scar.

Dichotomous key to species of *Lasionectria*

1. Ascospores striate 2
1. Ascospores smooth 5

2. Habitat aquatic; ascomatal wall yellow; ascospores 13–17 × 4.5–6 µm ... ***L. fournieri***
2. Habitat terrestrial; ascomatal wall pale orange to orange red or orange brown 3

3. Ascospores 8–11 × 3–4 µm ..... ***L. vulpina***
3. Ascospores larger 4

4. Ascospores two-celled, 16–20 × 3–3.7 µm ..... ***L. martinicensis***
4. Ascospores one-celled, 22.8–30 × 7.5–10.5 µm ..... ***L. calamicola***

5. Ascomata with scattered hairs 14–47 µm long, evenly distributed, not bound in fascicles; ascospores 10–12.5 × 3–3.5 µm; on palm .. ***L. marigotensis***
5. Ascomata with both scattered and fasciculate hairs; on other plant 6

6. Ascomata with scattered hairs 12–18 µm long and fasciculate hairs 30–36 µm long around the apex; ascospores 8.5–9.5 × 3–3.5 µm; on wood ..... ***L. mantuana***
6. Ascomata with hairs up to 100 µm long; ascospores 11–15 × 3–4 µm; on herbaceous stems. ..... ***L. sylvana***

Discussion

The two species described herein meet all the key features of *Lasionectria* as defined by Rossman et al. (1999). They differ from the most closely morphologically related genus *Ijuhya* by ascomata lacking a discoid apex and an apical crown of fasciculate hairs and by having an ascomatal wall more than 20 µm thick, composed of globose thick-walled cells in the outer region.

Lasionectria marigotensis can be recognized by the combination of white to pale orange ascomata with scattered erect hairs evenly distributed on the ascomatal surface and the relatively small, smooth-walled ascospores. Its occurrence on palm might be significant if further collections confirm a host preference or specificity. Another *Lasionectria* species reported from palm is *L. calamicola* J. Fröhl. & K.D. Hyde, known from two collections from Australia and Brunei Darussalam (Fröhlich & Hyde 2000). This taxon clearly differs from *L. marigotensis* in having orange brown ascomata bearing hairs arranged in fascicles and one-celled ascospores with striate walls.

Lasionectria martinicensis is unambiguously distinguished from other species based on its large ascospores with a conspicuously striate perispore easily loosening from the epispore. Other species of *Lasionectria* known to have striate ascospores are *L. calamicola*, *L. fournieri* Lechat, and *L. vulpina* (Cooke) Rossman & Samuels. The former differs in having one-celled ascospores 22.8–30 × 7.5–10.5 µm and in occurring on palm. *Lasionectria fournieri* occurs exclusively on submerged wood and its ascospores are markedly wider than those of *L. martinicensis*, while *L. vulpina* differs in having smaller ascospores 8–11 × 3–4 µm.

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Steccherinum straminellum, a new record for Italy

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Abstract — The first Italian record of *Steccherinum straminellum* is reported from Sicily. This collection represents the first record on wood of broadleaved trees. A description and line drawing of the species based on the Sicilian specimens are provided along with notes on the taxonomy, ecology, and distribution of this rare taxon.

Key words —*Aphyllophorales*, *Corticiaceae*, wood-inhabiting fungi

Introduction

Knowledge of fungal diversity in Italy has increased remarkably over the last five years (Venturella et al. 2011). Of the 1582 wood-decay fungi recorded in Italy, 1241 represent basidiomycetes, including 770 aphyllophoroid fungi (Saitta et al. 2011). Seventeen species of *Steccherinum* Gray are known from Italy (Bernicchia & Gorjón 2010).

Steccherinum is characterized by odontoid hymenophore, encrusted pseudocystidia, and smooth thin-walled inamyloid basidiospores. Recently, the genus has been included in the family *Meruliaceae* along with the poroid genus *Junghuhnia* (Larsson 2007). *Steccherinum straminellum* is a very rare species previously collected only in Portugal (Bernicchia & Gorjón 2010, Melo 1995). Originally described as *Odontia straminella* Bres. (Bresadola 1902), the species was transferred to *Steccherinum* seventeen years ago (Melo 1995).

Materials & methods

The basidiomata were identified while fresh and microscopic features were observed in Melzer's reagent and solution of potassium hydroxide (KOH 5%) using a Leica microscope DMLB. The spore measurements were based on 50 observations for each specimen. The nomenclature is referred to MycoBank (http://www.mycobank.org). Locality coordinates were derived from the 1:50.000 scale edition of the Official Map of

the Italian State (I.G.M.I.), following the methodology proposed by Padovan (1994). The collected specimens are preserved in the Herbarium Mediterraneum Panormitanum, Palermo (PAL).

Taxonomy

Steccherinum straminellum (Bres.) Melo, Mycotaxon 54: 126. 1995. FIGS 1–2

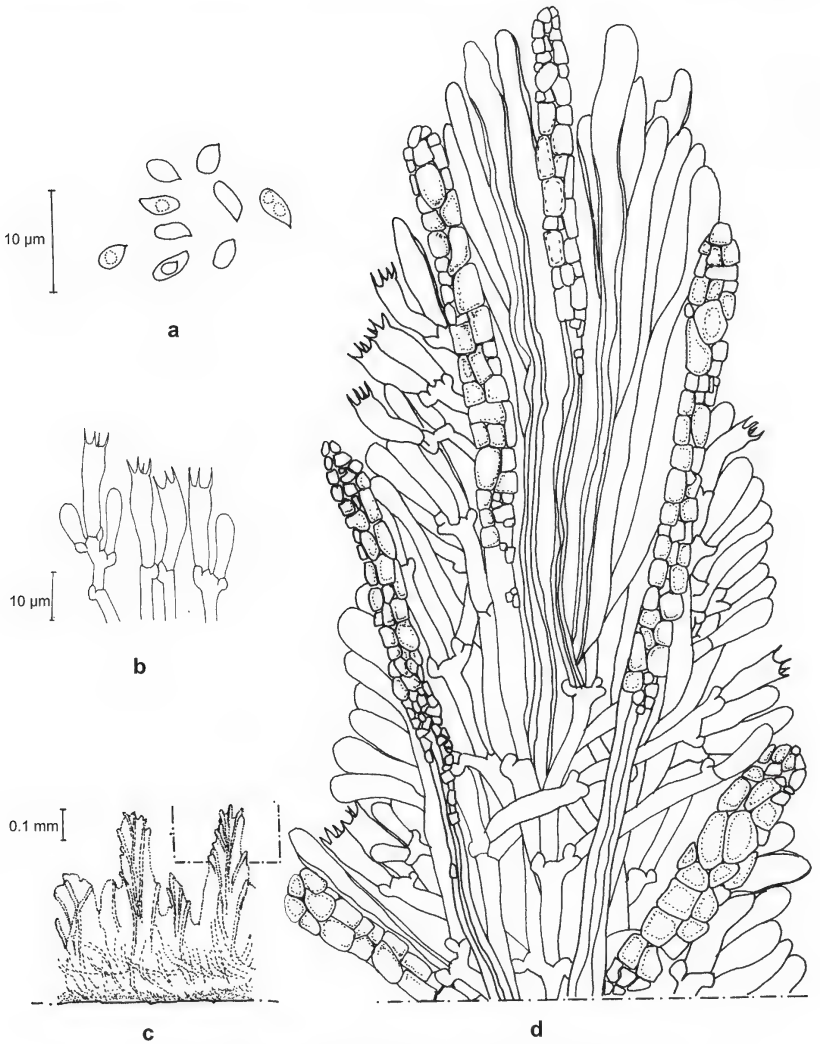

FIG. 1. *Steccherinum straminellum*, a. spores (PAL 02047 Mic); b. basidia (PAL 02047 Mic); c. section through basidiome (PAL 02050 Mic); d. section through apical part of a tooth (PAL 02050 Mic).

FIG. 2. *Steccherinum straminellum* basidiome on fallen branch of *Quercus ilex*.

Basidiome annual, resupinate, effused, adnate, broadly attached, rhizomorphs well developed, pileus surface white to pale-ochraceous, margin fimbriate, hymenophore odontioid to hydnoid, aculei up to 0.5 mm long and up 0.2 mm broad. Hyphal system dimitic, generative hyphae hyaline, thin-walled, 2.3–4.2 µm wide.

Pseudocystidia numerous, cylindrical with obtuse apex, strongly incrusted in the apical part, 7–12 µm wide, distributed along the aculei, sometimes protruding, thick-walled, becoming thin-walled towards apex. Basidia subclavate, 15–17 × 4.5–5.5 µm, with 4 sterigmata and basal clamps. Basidiospores 3.5–4(–4.5) × 2–2.2 µm, smooth, ellipsoid to subcylindrical, thin-walled, inamyloid.

SPECIMENS EXAMINED: **ITALY**, **SICILY**, PALERMO, Monte Petroso, I.G.M.I. 594123, 560 m, woodland dominated by *Quercus ilex* L., on fallen branches and trunk of *Q. ilex*, 03 Oct 2010, coll. A. Saitta (PAL 02047 Mic); 08 Mar 2011, coll. A. Saitta (PAL 02050 Mic); Casa Lo Curto, I.G.M.I. 609122, 720 m, mixed wood of *Q. suber* L. and *Q. virgiliana* (Ten.) Ten., on fallen branches of *Q. virgiliana*, 06 May 2010, coll. A. Saitta (PAL 02024 Mic).

Discussion

Steccherinum is represented by eighteen taxa in Europe, eight of which (including our new record) are currently reported for Italy: *S. bourdotii* Saliba & A. David, *S. fimbriatum* (Pers.) J. Erikss., *S. litschaueri* (Bourdot & Galzin) J. Erikss., *S. ochraceum* (Pers.) Gray, *S. oreophilum* Lindsey & Gilb., *S. robustius* (J. Erikss. & S. Lundell) J. Erikss., *S. straminellum*, and *S. subcrinale* (Peck) Ryvarden (Bernicchia & Gorjón 2010; this paper). *Steccherinum oreophilum*, *S. robustius*, and *S. subcrinale* are very rare in Italy (Bernicchia & Gorjón 2010).

The morphological features of *S. straminellum* are very close to *S. litschaueri*. The two species differ only in the filamentous margin and the length of aculei that can reach 1 mm in *S. litschaueri*. Moreover, *S. litschaueri* has thinner cystidia and subcylindrical to cylindrical, up to 5.5 µm long spores (Eriksson et al. 1984).

Previously *S. straminellum* had been collected only on conifers (Bresadola 1902; Melo 1995), but now it has been found growing on fallen branches of hardwoods, *Quercus ilex* and *Q. virgiliana,* in two localities of Sicily (southern Italy).

Based on this new finding, *S. straminellum* has a restricted southern European geographical distribution (Sicily in southern Italy, Portugal). In Sicily, *S. ochraceum* is the only common *Steccherinum* species. Our collection shows again that oak branches and trunks seem to be the preferred *Steccherinum* substrate in Sicily (Saitta et al. 2004).

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A new species of *Inonotus* (*Basidiomycotina, Hymenochaetales*) from tropical Yunnan, China

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Abstract — *Inonotus puerensis* sp. nov. is reported from tropical China. It is characterized by having a perennial habit, duplex context, a monomitic hyphal structure, presence of both hyphoid setae and hymenial setae, and coloured basidiospores. Detailed descriptions with illustration are provided for the new species, and its relationships with similar species are discussed.

Key words — *Hymenochaetaceae*, taxonomy, white rot, wood-inhabiting fungi

Introduction

Yunnan Province is located in southwestern China and very rich in fungal diversity because of its abundant and diverse vegetation. Although around 300 wood-inhabiting fungi have been recorded in this area (Dai 2011, 2012), including several recently published new polypore species (Wei et al. 2006; Yuan & Dai 2008; Cui et al. 2009, 2011; Dai & Korhonen 2009; Dai & Yuan 2009; Dai 2010), many taxa are still undescribed, especially the tropical species. In 2011 we surveyed wood-inhabiting fungi in tropical Yunnan and collected an unknown species of *Inonotus* P. Karst. The species has a perennial habit, duplex context, a monomitic hyphal structure, both hyphoid setae and hymenial setae, and coloured basidiospores. Since Ryvarden's (2005) monograph on *Inonotus* was published, more new species have been described (Balezi & Decock 2009; Dai 2010; Wu et al. 2012). After checking all existing names, we found none matching all the above characters. Therefore, we propose here a new species, *Inonotus puerensis*.

Materials & methods

Voucher specimens are deposited in the herbarium of Beijing Forestry University (BJFC). The specimens were examined microscopically according to Cui et al. (2011). Abbreviations include: IKI = Melzer's reagent, KOH = 5% potassium hydroxide,

CB = Cotton Blue, IKI– = inamyloid and nondextrinoid, CB– = acyanophilous, L = mean spore length (arithmetical average of all spores), W = mean spore width (arithmetical average of all spores), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width of each specimen), n = the number of spores measured from given number of specimens. In spore and seta size ranges, the 5% of the measurements excluded from each end of the range are given in parentheses. Special color terms follow Petersen (1996).

Taxonomy

Inonotus puerensis Hai J. Li & S.H. He, **sp. nov.** FIG. 1

MycoBank MB 564891

Differs from other *Inonotus* species by its perennial habit, duplex context, monomitic hyphal structure, presence of both hyphoid setae and hymenial setae, and coloured basidiospores.

Type: China. Yunnan Province, Pu'er, Caiyanghe Nature Reserve, on fallen angiosperm trunk, 6.VI.2011 Dai 12241 (**holotype**, BJFC).

Etymology: *puerensis* (Lat.): referring to the locality name of Puer, Yunnan Province, China.

Fruitbody: Basidiocarps perennial, pileate, solitary, without odour or taste and hard corky when fresh, becoming woody hard upon drying. Pilei applanate, projecting up to 3 cm long, 4.5 cm wide and 6 mm thick at base. Pileal surface fuscous when dry, velutinate to tomentum, concentrically sulcate and zoned; margin yellowish brown, obtuse. Pore surface cinnamon when fresh, become dark brown when bruised, clay-buff when dry, glancing; sterile margin distinct, yellowish brown, up to 2 mm wide, bearing abundant hyphoid setae (by lens); pores circular to angular, 7–9 per mm; dissepiments thin, entire, matted. Context cinnamon, up to 2 mm thick, woody hard, duplex, with a black zone between upper velutinate or tomentum and lower context; lower context woody hard, up to 1.5 mm thick, upper velutinate or tomentum up to 0.5 mm thick; a thick dark brown line present between context and tubes. Tubes concolorous with pore surface, woody hard, distinctly stratified, up to 4 mm long.

Hyphal structure: Hyphal system monomitic, generative hyphae simple septate, IKI–, CB–; tissue darkening but otherwise unchanged in KOH.

Context: Generative hyphae yellowish to brownish, thick-walled with a wide lumen, more or less straight, unbranched, frequently septate, interwoven, 3.2–4.7 μm in diam.; hyphoid setae prominent, not dominant, dark brown, distinctly thick-walled with a narrow lumen, some parts subsolid, straight, tapering to apex, 240–400 × 10–13 μm; hyphae in the black zone dark brown, distinctly thick-walled with a narrow lumen, dark brown, flexuous, strongly agglutinate, interwoven, 3–4 μm in diam.; hyphae in the tomentum brown, thick-walled with a narrow to wide lumen, agglutinate, interwoven, 3–6 μm in diam.

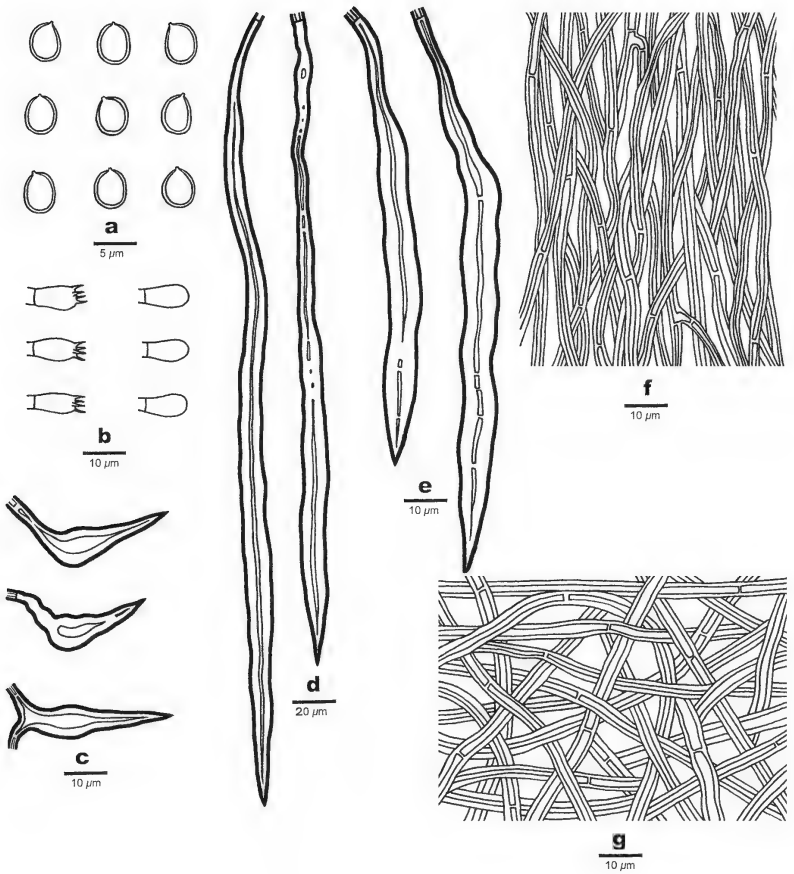

Fig. 1. Microscopic structures of *Inonotus puerensis* (holotype).
a: Basidiospores. b: Basidia and basidioles. c: Hymenial setae. d: Hyphoid setae from context.
e: Hyphoid setae from trama. f: Hyphae from trama. g: Hyphae from context.

Tubes: Generative hyphae hyaline to yellowish brown, thin- to thick-walled, rarely branched, frequently septate, straight, subparallel along the tubes, 2.5–3.9 μm in diam; hyphoid setae not dominant, prominent, dark brown, distinctly thick-walled with a narrow lumen, some parts subsolid, straight, tapering to apex, 90–250 × 8–12 μm. Hymenial setae frequent, subulate, tapering to apex, dark brown, thick-walled, 25–42 × 7–11 μm; cystidia and cystidioles absent; basidia barrel-shaped, bearing four sterigmata and a simple septum at the base, 9–11 × 5–6 μm; basidioles in shape similar to basidia, but slightly smaller.

Spores: Basidiospores broadly ellipsoid, yellowish to golden yellow, thick-walled, smooth, IKI–, CB–, (4.4–)4.5–5(–5.2) × (3.6–)3.7–4(–4.2) μm, L = 4.78 μm, W = 3.9 μm, Q = 1.23 (n = 30/1).

Type of rot: White rot.

Remarks: *Inonotus puerensis* is unique in the genus for its perennial habit, duplex context, monomitic hyphal structure, presence of both hyphoid and hymenial setae, and coloured basidiospores.

Macro-morphologically *Inonotus puerensis* resembles members of the *I. baumii* complex by sharing pileate and perennial basidiocarps, abundant hymenial setae, and thick-walled yellowish basidiospores (Dai 2010). However, *I. puerensis* has a monomitic hyphal structure and hyphoid setae, while species in the *I. baumii* complex have a dimitic tramal structure and lack hyphoid setae.

Microscopically *Inonotus puerensis* is similar to *I. indurescens* Y.C. Dai, also described from Yunnan Province (Dai & Zhou 2000). Both have a monomitic hyphal structure, hyphoid setae, and yellowish spores, but *I. indurescens* is an annual species with larger pores (5–7 per mm) and dentate dissepiments. In addition, its hyphoid setae occur in the trama and only sometimes curve and penetrate into hymenium (Dai & Zhou 2000).

Inonotus pseudoglomeratus Ryvarden, described from South America (Ryvarden 2002), resembles *I. puerensis* in pileate basidiocarps, presence of both hyphoid setae and hymenial setae, and coloured basidiospores. However, *I. pseudoglomeratus* is an annual species with larger pores (4–6 per mm), shorter hymenial setae (15–25 × 6–10 μm), and bigger basidiospores (5–6 × 4–4.3 μm, Ryvarden 2002).

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A new species of *Grammothelopsis* *(Polyporales, Basidiomycota)* from southern China

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Abstract — A new polypore, *Grammothelopsis subtropica*, is described and illustrated based on three specimens collected in Guangdong and Hunan provinces, southern China. Macroscopically, the new species is characterized by an annual growth habit, resupinate basidiocarps with cream pore surface, and large pores (1–2 per mm); microscopically, it has a dimitic hyphal system with strongly dextrinoid and cyanophilous skeletal hyphae, and its basidiospores are ellipsoid to oblong-ellipsoid, thick-walled, slightly dextrinoid, slightly cyanophilous, and 12.7–15.2 × 4.9–5.9 µm. In addition, dendrohyphidia are abundant in dissepiments. An identification key to the worldwide species of *Grammothelopsis* is provided.

Key words — lignicolous and poroid fungi, *Polyporaceae*, taxonomy

Introduction

Grammothelopsis Jülich was established by Jülich (1982) and typified by *G. macrospora* (Ryvarden) Jülich. It is characterized by resupinate to effused basidiocarps, shallow irregular pores, and large thick-walled variably dextrinoid basidiospores. *Grammothelopsis* species occur mostly in tropical Africa and America (Robledo & Ryvarden 2007, Ryvarden & de Meijer 2002), with one species recently described from tropical China (Dai et al. 2011).

As a result of recent surveys of the diversity of wood-inhabiting fungi in southern China, many new fungal species have been described from tropical and subtropical areas of the country (Cui & Dai 2008, 2011; Cui et al. 2009, 2010, 2011; Dai 2012a; Dai & Korhonen 2009; Dai et al. 2003, 2004, 2009, 2010, 2011; Du & Cui 2009; Jia & Cui 2011; Li & Cui 2010; Ma et al. 2011; Yuan 2011; Yuan & Dai 2008a,b; Zhang et al. 2012; Zhou & Dai 2012). However, the diversity and richness of tropical polypores in China are still not well known (Dai 2012b), and there are still many unidentified specimens from tropical China. During examination of southern Chinese polypore collections, an

additional undescribed *Grammothelopsis* species was found, which is described and illustrated in the present paper.

Materials & methods

The studied specimens are deposited at the herbaria of the Institute of Microbiology, Beijing Forestry University (BJFC) and the Institute of Applied Ecology, Chinese Academy of Sciences (IFP). The microscopic routine used in the study follows Dai (2010). Sections were studied at magnifications up to ×1000 using a Nikon Eclipse E 80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Microscopic features, measurements, and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. Spores were measured from sections cut from the tubes. In presenting the spore size variation, the 5% of measurements excluded from each end of the range are given in parentheses. Abbreviations include: IKI = Melzer's reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, n = number of spores measured from given number of specimens. Special color terms follow Petersen (1996).

Taxonomy

Grammothelopsis subtropica B.K. Cui & C.L. Zhao, **sp. nov.** Fig. 1

MycoBank MB 564797

Differs from other *Grammothelopsis* species by an annual growth habit, resupinate basidiocarps with creamy shallow large pores (1–2 per mm), ellipsoid to oblong ellipsoid, slightly dextrinoid and slightly cyanophilous basidiospores, presence of dendrohyphidia, and absence of hyphal pegs.

Type: China, Guangdong Province, Fengkai County, Heishiding Nature Reserve, on fallen angiosperm branch, 1.VII.2010, Cui 9035 (**holotype**, BJFC).

Etymology: *subtropica* (Lat.): refers to the species being distributed in the subtropics.

Fruitbody — Basidiocarps annual, resupinate, adnate, soft corky, without odor or taste when fresh, becoming corky upon drying, ≤ 7.5 cm long, 1.6 cm wide, 0.7 mm thick at center. Pore surface white to cream when fresh, cream upon drying; pores round to angular, 1–2 per mm; dissepiments thin, entire. Sterile margin narrow, white, ≤ 1 mm wide. Subiculum cream, thin, ca. 0.2 mm thick. Tubes concolorous with pore surface, corky, ≤ 0.5 mm long.

Hyphal structure — Hyphal system dimitic; generative hyphae with clamp connections; skeletal hyphae strongly dextrinoid in Melzer's reagent, CB+, tissues unchanged in KOH.

Subiculum — Generative hyphae infrequent, hyaline, thin-walled, 2.1–2.5 μm in diam; skeletal hyphae dominant, hyaline, thick-walled with a wide to narrow lumen, frequently branched, flexuous, interwoven, 2.3–2.8 μm in diam.

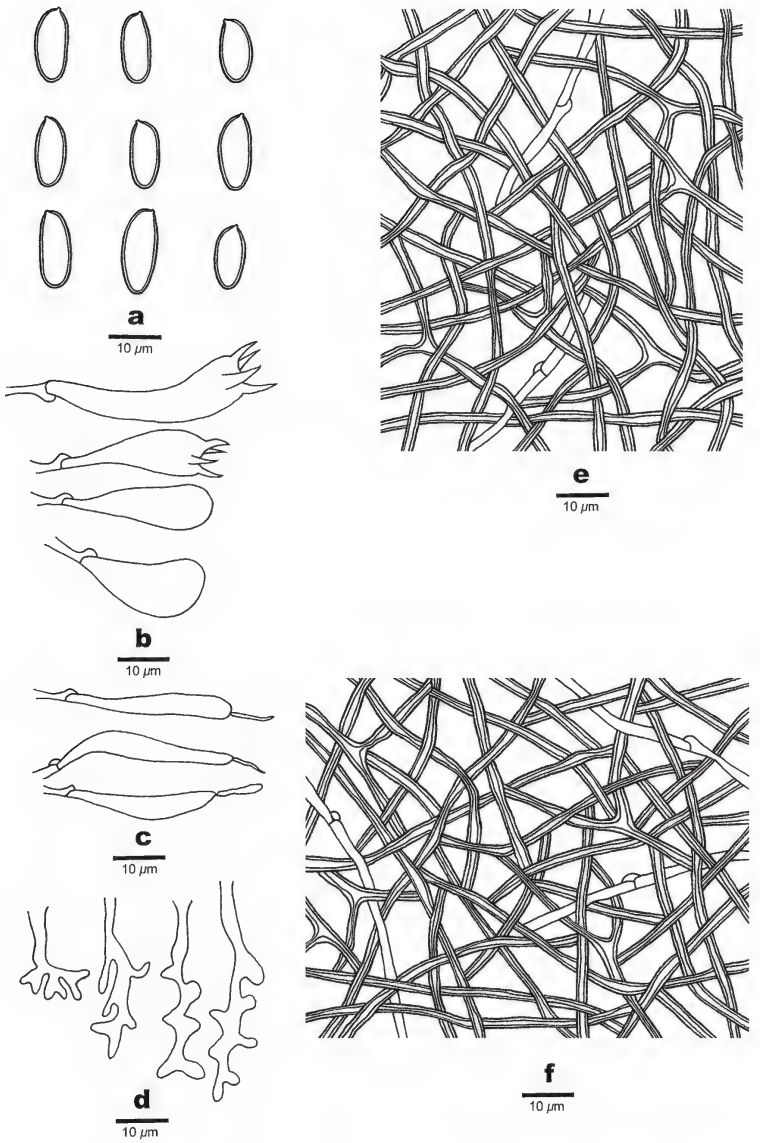

FIGURE 1. *Grammothelopsis subtropica* (holotype) microscopic structures.
a: Basidiospores. b: Basidia and basidioles. c: Cystidioles.
d: Dendrohyphidia. e: Hyphae from trama. f: Hyphae from subiculum.

Tubes — Generative hyphae infrequent, hyaline, thin-walled, 2–2.3 µm in diam; skeletal hyphae dominant, hyaline, thick-walled with a wide to narrow lumen, frequently branched, flexuous, interwoven, 2–2.5 µm in diam. Dendrohyphidia abundant in dissepiments, hyaline, thin-walled, ≤ 45 µm long. Cystidia absent, fusoid cystidioles present, hyaline, thin-walled, 28.1–36 × 4.2–6.4 µm; basidia clavate to pear-shaped, with four sterigmata and a basal clamp connection, 36.5–39.1 × 8.9–9.8 µm; basidioles dominant, mostly pear-shaped, slightly smaller than basidia.

Spores — Basidiospores ellipsoid to oblong-ellipsoid, hyaline, thick-walled, smooth, slightly dextrinoid in Melzer's reagent, weakly CB+, (11.2–)12.7–15.2(–16) × (4.7–)4.9–5.9(–6.1) µm, L = 13.7 µm, W = 5.3 µm, Q = 2.4–2.7 (n = 90/3).

Additional specimens examined: **China. Guangdong Province**, Fengkai County, Heishiding Nature Reserve, on fallen angiosperm branch, 1.VII.2010, Cui 9041 (BJFC); **Hunan Province**, Yizhang County, Mangshan Nature Reserve, on fallen angiosperm trunk, 24.VI.2007, Li 1662 (IFP).

Discussion

Six species have been recorded in *Grammothelopsis*: *G. bambusicola* Ryvarden & de Meijer, *G. incrustata* A. David & Rajchenb., *G. neotropica* Robledo & Ryvarden, and *G. puiggarii* (Speg.) Rajchenb. & J.E. Wright were found in Central and South America (David & Rajchenberg 1985; Rajchenberg & Wright 1987; Robledo & Ryvarden 2007; Ryvarden & de Meijer 2002), *G. macrospora* in tropical Africa (Ryvarden & Johansen 1980), and *G. asiatica* Y.C. Dai & B.K. Cui in tropical China (Dai et al. 2011).

Grammothelopsis bambusicola has a dimitic hyphal system with strongly dextrinoid skeletal hyphae and presence of dendrohyphidia. However, it differs from *G. subtropica* in having smaller pores (4 per mm) and strongly dextrinoid, wider basidiospores (11–13.5 × 7.8–9 µm: measured from type specimen by Dai et al. 2011).

Grammothelopsis macrospora may be confused with *G. subtropica* due to its resupinate basidiocarps with larger pores (1–2 per mm) and presence of dendrohyphidia, but it is distinguished from *G. subtropica* by its non-dextrinoid and unbranched skeletal hyphae. In addition, its basidiospores are strongly dextrinoid and larger (15–20 × 7.5–11 µm: Robledo & Ryvarden 2007).

Grammothelopsis incrustata and *G. neotropica* also have resupinate basidiocarps and a dimitic hyphal system, but both species have smaller pores (3–4 per mm), non-dextrinoid skeletal hyphae, and distinctly larger basidiospores (*G. incrustata*, 16–22 × 6–8 µm; *G. neotropica*, 18–20 × 7–8 µm: Robledo & Ryvarden 2007).

Grammothelopsis puiggarii shares with *G. subtropica* larger pores (1–2 per mm) and a dimitic hyphal system with strongly dextrinoid skeletal hyphae, but

G. puiggarii has larger basidiospores (17–20 × 10–12 μm) and lacks dendrohyphidia (Robledo & Ryvarden 2007).

Grammothelopsis asiatica resembles *G. subtropica* in resupinate basidiocarps, a dimitic hyphal system, and similar basidiospores (10.5–13 × 5.4–6 μm). However, *G. asiatica* has smaller pores (3–4 per mm), its skeletal hyphae and basidiospores are non-dextrinoid, and it lacks dendrohyphidia (Dai et al. 2011).

Key to the species of *Grammothelopsis*

1. Dendrohyphidia present 2
1. Dendrohyphidia absent 4

2. Pores 3–4 per mm ..... *G. bambusicola*
2. Pores 1–2 per mm 3

3. Basidiospores >15 μm long, hyphal pegs present ..... *G. macrospora*
3. Basidiospores <15 μm long, hyphal pegs absent ..... *G. subtropica*

4. Generative hyphae simple septate ..... *G. incrustata*
4. Generative hyphae with clamp connections 5

5. Pores 1–2 per mm, basidiospores strongly dextrinoid ..... *G. puiggarii*
5. Pores 3–4 per mm, basidiospores non-dextrinoid 6

6. Basidiospores >15 μm long ..... *G. neotropica*
6. Basidiospores <15 μm long ..... *G. asiatica*

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Two new species of white truffle from China

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Abstract — Two new white truffle species from China are described and illustrated. *Tuber pseudomagnatum* is characterized by yellow white ascomata with blackish gleba and small elliptic ascospores with a large meshed reticulum. *Tuber liyuanum* is separated from other species by its white ascomata, brown gleba, and elliptic to long elliptic ascospores with a regular reticulum. ITS based sequence analyses support the erection of the two new species.

Key words — *Ascomycota*, *Tuberaceae*, taxonomy

Introduction

Southwestern China is a place where new truffle species are being found on a regular basis. Recently, we were sent 4 kilos of fresh white truffles from Yunnan Province by someone who has been involved in the Chinese truffle business for more than a decade. The truffles gave off a not unpleasant, strong, pungent aroma, but after boiling in 3% salt-water solution, they developed a pleasant flavor. These truffles could be divided into two different groups according to the exterior characteristics of ascomata. One was yellow white and tasted a little sweet, while the other was pure white (at least at the furrows) and tasted sweet. They resembled several known white truffles, such as *Tuber latisporum* Juan Chen & P.G. Liu (Chen & Liu 2007) from China, *T. magnatum* Picco and *T. borchii* Vittad. from Europe (Riousset et al. 2001), and *T. oregonense* Trappe et al. and *T. gibbosum* Harkn. from North America (Bonito et al. 2010). However, detailed morphological observation and DNA analysis revealed them as new species, which we describe here.

Materials & methods

Morphological studies

The truffles were collected under conifers or mixed woodlands in Huize county, Yunnan Province, China. Macroscopic characters were described both from fresh and rehydrated dried specimens, and microscopic characters from razor-blade sections

mounted in 3% KOH (w/v), Melzer's reagent and 0.1% (w/v) cotton blue in lactic acid. For scanning electron microscopy (SEM), spores were scraped from the dried host gleba onto doubled-sided tape, which was mounted directly on an SEM stub and coated with gold-palladium. The treated materials were examined and photographed with a HITACHI S-4800 SEM. The specimens were deposited in BJTC (Herbarium of Biology Department, Capital Normal University, Beijing, China).

Molecular methods

Samples from herbarium material were crushed by shaking for 3 min at 30 Hz (Mixer Mill MM 301, Retsch, Haan, Germany) in a 1.5 ml tube together with one 3 mm diameter tungsten carbide ball. Total genomic DNA was then extracted using the PeqLab E.Z.N.A._Fungal DNA kit following the manufacturer's protocol. The ITS regions were amplified with PCR using the primers ITS1/ITS4 (White et al. 1990). PCR was performed in 50 µl reactions containing DNA template 2 µl, primer (10 µM) 2 µl each, and 2 × Master Mix (Tiangen Biotech (Beijing) Co. Ltd.) 25 µl. PCR reactions were run as follows: an initial denaturation at 95 °C for 3 min, followed by 30 cycles at 95 °C for 2 min, 55 °C for 25 s, 72 °C for 2 min and a final extension at 72 °C for 10 min. The PCR products were sent to Invitrogen Biotechnology Co. Ltd. (Beijing, China) for purifying, sequencing, and editing. The other ITS rDNA sequences included in this study (Table 1) were downloaded from GenBank.

Table 1. *Tuber* ITS rDNA sequences used in study.

Species (voucher specimens)	ITS
T. borchii	HM485344
	HM485343
T. dryophilum Tul. & C. Tul.	HM485353
	HM485354
T. gibbosum	FJ809868
T. latisporum	DQ898185
	DQ898183
T. liui A.S. Xu	DQ898182
T. liyuanum (BJTC FAN 162, holotype)	JQ771191
(BJTC FAN 187)	JQ771193
T. maculatum Vittad.	FM205649
	EU784428
T. magnatum	AJ586308
	EU807975
T. melanosporum Vittad.	AF132501
	AF106878
T. oligospermum (Tul. & C. Tul.) Trappe	FM205507
	FM205506
T. oregonense	FJ809881
	FJ809882
	FJ809870
T. puberulum Berk. & Broome	AJ969626
	AJ969625
T. pseudomagnatum (BJTC FAN 163, holotype)	JQ771192
T. scruposum R. Hesse	DQ011846
	DQ011845
T. zhongdianense X.Y. He et al.	DQ898187
	DQ898186

Phylogenetic analyses

DNA sequences were aligned with Clustal X (Thompson et al. 1997). The alignment was manually adjusted with Se-Al v.2.03a (Rambaut 2000). The aligned dataset was analyzed with maximum parsimony (MP) using PAUP*4.0b10 (Swofford 2002). Maximum parsimony analysis was conducted using heuristic searches with 1000 replicates of random-addition sequence, tree bisection reconnection (TBR) branch swapping algorithm. All characters were equally weighted and unordered. Gaps were treated as missing data to minimize homology assumptions. A bootstrap (BS) analysis was performed with 1000 replicates, each with 10 random taxon addition sequences. TBR branch swapping was employed. The Bayesian analysis was performed with MrBayes 3.1.2 (Huelsenbeck et al. 2001; Ronquist and Huelsenbeck 2003) with two sets of four chains (one cold and three heated) and the stoprule option in effect, halting the analyses at an average standard deviation of split frequencies of 0.01. The sample frequency was set to 100, and the first 25% trees were removed as burn-in. Bayesian posterior probabilities (PP) were obtained from the 50% majority rule consensus of the remaining trees. Two sequences derived from *Tuber melanosporum* (AF132501, AF106878) were used as outgroups.

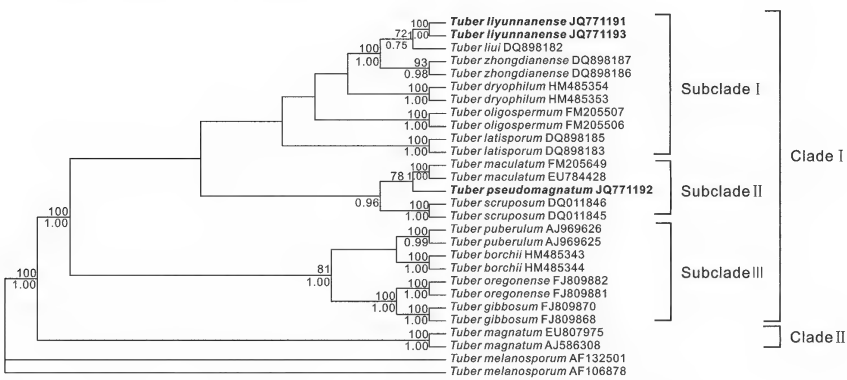

FIG.1. Phylogeny derived from maximum parsimony analysis of the ITS rDNA sequences of some *Tuber* species with pale and nearly glabrous ascomata and typical reticulate ascospores, using *T. melanosporum* as outgroups. Bootstrap values of more than 70% from 1000 replications are shown above the respective branches. Bayesian posterior probabilities (PP) were estimated and clades with PP>0.70 (70%) are marked under the branches.

Results

Molecular phylogenetics

326 of 603 characters were found to be parsimony-informative. Maximum parsimony analysis produced one most parsimonious tree with a length (TL) of 922 steps, consistency index (CI) of 0.6475, retention index (RI) of 0.8269 and rescaled consistency index (RCI) of 0.5354 (for all sites).

The phylogenetic analysis (FIG. 1) revealed that two clades were present with strong support (BS = 100, PP = 1.00). Clade I comprised 24 sequences of 13

species, while clade II was composed only of the *T. magnatum* sequences. *Tuber magnatum* ascomata appear very similar to those of many other white truffle species; however, its ascospores had large reticulum meshes. The DNA tree (Fig. 1) also shows considerable separation between *T. magnatum* and the other 13 white truffle species. Clade I contained three subclades. Subclade I comprised 11 sequences from six species: *T. liyuanum, T. liui, T. zhongdianense,* and *T. latisporum* from China, *T. dryophilum* from Europe, and *T. oligospermum* from Europe and North Africa. Subclade II contained five sequences from three species: *T. pseudomagnatum* from China and *T. maculatum* and *T. scruposum* from Europe. Subclade III is composed of eight sequences from four species: *T. puberulum* and *T. borchii* from Europe and *T. gibbosum* and *T. oregonense* from North America. The new species *T. liyuanum* fell into subclade I and grouped together with *T. liui* with moderate support (BS = 72). *Tuber liui,* an endemic Chinese species with brown colored ascomata and large ascospores reaching 70 µm long (Xu 1999), is currently known only from Tibet. The other new species, *T. pseudomagnatum,* fell into subclade II and grouped together with *T. maculatum* with moderate support (BS = 78).

Taxonomy

Tuber pseudomagnatum L. Fan, **sp. nov.** Fig. 2

MycoBank MB 564521

Differs from other *Tuber* species by its yellow white ascomata, blackish gleba, and small brown elliptic ascospores with reticulum.

Type: China. Yunnan Province, Huize County, in soil under *Pinus yunnanensis* Franch. forest, 22 Oct. 2011, Shao-pin Li 002 (**Holotype**, BJTC FAN163).

Etymology: *pseudomagnatum* (Lat.), referring to the great similarity to *T. magnatum*.

Ascomata globose or subglobose, sometimes irregular, 1.5–2 cm in diam., yellow white or cream white when fresh, surface smooth or very finely verrucose 30–50 µm high, glabrous. Odor pungent but pleasant when fresh, taste strong and sweet. Peridium 175–250 µm thick, two layers; outer layer pseudoparenchymatous, 75–150 µm thick including the verrucose, composed of globose or subglobose cells 7.5–20 µm in diam., with thin or slightly thickened walls, hyaline; inner layer texture intricate, composed of hyphae with hyaline, thin walled cells 5–7.5 µm broad. Gleba white at first, dark brown or nearly blackish at maturity, marbled with large and rare whitish veins. Asci subglobose or elliptic, hyaline, thin walled, 75–100 × 60–75 µm, sessile, 1–4-spored. Ascospores mostly elliptic, only a few broad elliptic to subglobose, hyaline or light brown when young, brown to dark brown at maturity, 22.5–35(–40) × 20–27.5(–30) µm excluding the ornamentation; ornamentation reticulate, regular and deep, 5–7.5 µm high, the meshes large and 3–4 across the spore width.

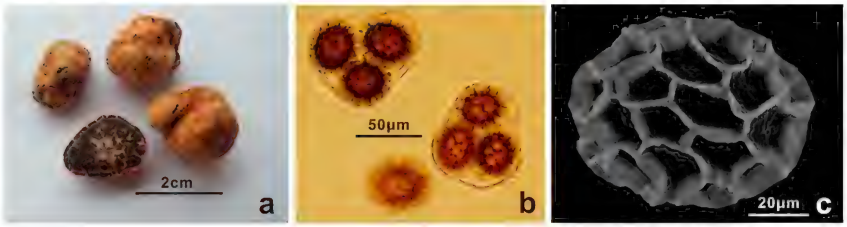

FIG.2. *Tuber pseudomagnatum* (BJTC FAN163, holotype). a. Ascomata. b. Asci and ascospores observed under light microscope. c. Ascospore observed under scanning electronic microscope.

COMMENTS—Three species of white truffle are similar to *Tuber pseudomagnatum*. The similar ascoma appearance and similar pleasant odor makes *T. magnatum* easily confusable with young *T. pseudomagnatum* truffles, but its pale colored gleba and very broadly elliptic to subglobose ascospores readily distinguishes it (Riousset et al. 2001). Moreover, *Tuber magnatum* is normally found in broadleaf forests, while *T. pseudomagnatum* fruits in coniferous forests. *Tuber latisporum*, a species endemic to China, has a similar whitish ascoma and blackish gleba (Chen & Liu 2007), but differs from *T. pseudomagnatum* in its red brown, broadly elliptic to subglobose ascospores and pungent, unpleasant odor. *Tuber borchii* from Europe also has a dark gleba at maturity but differs from *T. pseudomagnatum* in its large broad ellipsoid ascospores with small meshes, a peridium with inflated cells, and ascomata covered with abundant hairs, particularly in cracks (Riousset et al. 2001).

The phylogenetic analysis (FIG. 1) groups *T. pseudomagnatum* together with *T. maculatum* with moderate support (BS = 78), but *T. maculatum* has a typically prosenchymatous peridium, which distinguishes the two species.

Tuber liyuanum L. Fan & J.Z. Cao, **sp. nov.** FIG. 3

MYCOBANK MB 564522

Differs from other *Tuber* species by its white ascomata, brown gleba, and elliptic to long elliptic ascospores with a regular reticulum.

TYPE: China. Yunnan Province, Huize County, in soil under mixed forest with *Pinus yunnanensis* as dominant, 22 Oct. 2011, Shao-pin Li 001 (**Holotype**, BJTC FAN162).

ETYMOLOGY: *liyuanum* (Lat.), named after the Yunnan province of China where the truffles were found as well as honoring Prof. LI Yu, a Chinese mycologist.

ASCOMATA globose or subglobose, convoluted, irregularly lobed with furrows, sometimes clearly cavity-like at the bases, 0.5–8 cm in diam., white or pale white when fresh especially in furrows, grey white or pale white to pale grey brown or grey brown after drying, surface smooth, glabrous or very fine puberulent. Odor moderate to strong or pungent but pleasant when fresh, taste strong and pleasant. PERIDIUM 300–350 μm thick, two layers; outer layer 200–250 μm thick, pseudoparenchymatous, composed of globose, subglobose or irregular

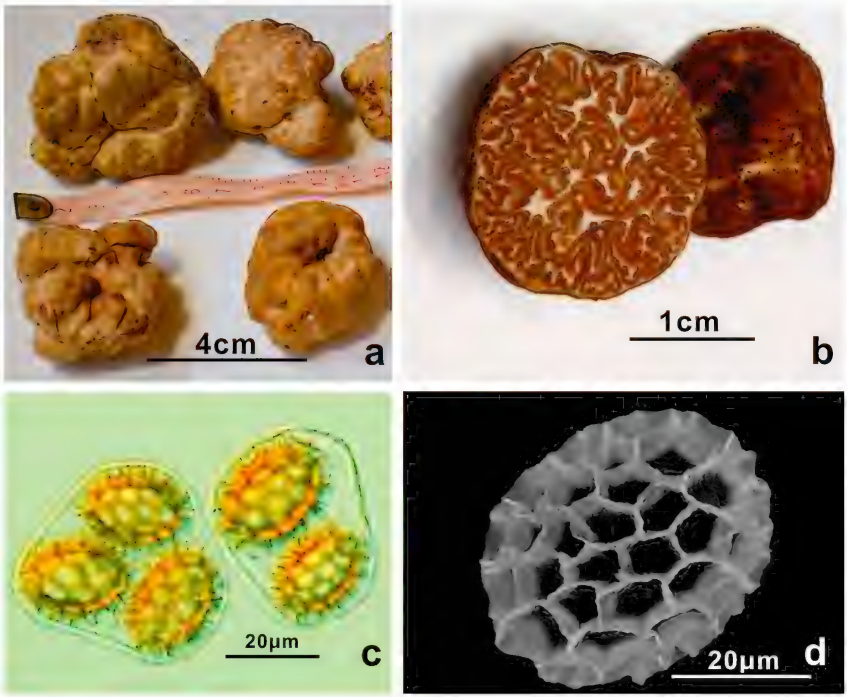

Fig.3. *Tuber liyuanum* (BJTC FAN162, holotype). a,b. Ascomata. c. Asci and ascospores observed with light microscope. d. Ascospore observed with scanning electronic microscope.

shaped cells 12.5–37.5 μm in diam., hyaline, thin walled or slightly thickened, occasionally with a few hyphae-like hairs arising from the outermost cells of furrow areas, hairs 50–100 μm long and 5 μm broad at base, tapered, 1–4 septate; inner layer 50–150 μm thick, texture intricate, composed of hyphae with hyaline, thin walled cells 2.5–5(–7.5) μm broad. Gleba light at first, brown at maturity, never blackish, marbled with narrow and numerous whitish veins. Asci subglobose or elliptic, hyaline, thin walled, 80–92.5 × 62.5–70 μm, sessile, 1–4-spored. Ascospores mostly elliptic to long-elliptic, a few broad elliptic, hyaline or light brown when young, yellow to light yellow brown at maturity, 35–50 × 27.5–32.5 μm for 2–4-spored asci and 57.5–60 × 40–42.5 μm for 1-spored asci excluding the ornamentation, ornamentation reticulate, regular or irregular, 4–6 μm high, meshes varying in size, mostly 4–6(–7) across the spore width.

Additional specimen examined — **China. Yunnan Province**, Huize county, in soil under conifers, 28 Dec 2011, Jin-zhong Cao 514 (BJTC FAN187)

Comments — *Tuber liyuanum* is one of the most common white truffle species in Chinese truffle markets and can be easily recognized by its medium to large

white ascomata, brown colored gleba with distinct white veins, and elliptic to long elliptic ascospores with a regular reticulum.

European truffles with pale ascomata and reticulate ascospores include *T. borchii*, *T. dryophilum*, *T. maculatum*, *T. magnatum*, *T. oligospermum*, *T. puberulum*, and *T. scruposum*. *Tuber borchii* differs from *T. liyuanum* by its dark colored gleba and broadly elliptic brown ascospores, while *T. dryophilum* differs by its dark colored gleba and brown ascospores with large reticulum meshes and *T. maculatum* by its glabrous peridium and prosenchymatous peridium structure. *Tuber magnatum* differs in having a glabrous peridium and very broadly elliptic to subglobose ascospores with 2–3 meshes across the spore width, *T. oligospermum* in its prosenchymatous peridium and globose ascospores, *T. puberulum* by its subglobose-globose ascospores and small reticulum meshes, and *T. scruposum* by its distinctly verrucose ascomal surface and dark colored gleba.

In North America, members of the Oregon white truffle *T. gibbosum* species complex resemble *T. liyuanum* but differ in an ascomal surface "with scattered to abundant, emergent hyphae having walls with irregularly thickened bands to produce a beaded appearance by maturity" (Bonito et al. 2010).

In China, there are three endemic species similar to *T. liyuanum*. *Tuber latisporum* differs in a blackish gleba and very broadly ellipsoid to subglobose ascospores, while *Tuber liui* has brown colored ascomata and large (≤70 µm long) ascospores (Xu 1999). *Tuber zhongdianense* is separated by its brown colored ascomata, 1–2(rarely 3–4)-spored asci, broadly ellipsoid ascospores, and a spore reticulum averaging 2 µm tall (He et al. 2004).

Although *T. liyuanum* sequences group with that of *T. liui* with moderate support (BS = 72) and are close to those of *T. zhongdianense* (Fig. 1), the three species are morphologically very different, suggesting that the three species are closely related but *T. liyuanum* is a distinct species.

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Two new species of *Ceriporia* (*Basidiomycota, Polyporales*) with a key to the accepted species in China

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Abstract — Two new polypores, *Ceriporia inflata* and *C. jiangxiensis* spp. nov. are described from China: *C. inflata* is characterized by large pores (2–3 per mm), cylindrical to oblong-ellipsoid basidiospores (4.7–5.2 × 2–2.4 µm), and hyphae that swell in KOH; *C. jiangxiensis* has ellipsoid, cylindrical to oblong-ellipsoid basidiospores (4.8–5.8 × 2.1–2.7 µm), mycelioid cystidia, and distinctly thick-walled subicular hyphae. A key to accepted species of *Ceriporia* in China is provided.

Key words — wood-inhabiting fungi, *Phanerochaetaceae,* taxonomy

Introduction

The principal characteristics of *Ceriporia* Donk, described by Donk (1933), are resupinate basidiocarps, an annual growth habit, a monomitic hyphal system with simple septate generative hyphae, and thin-walled, smooth, and cylindrical, oblong-ellipsoid or allantoid basidiospores (Núñez & Ryvarden 2001; Pieri & Rivoire 1997). Of the 32 *Ceriporia* species accepted worldwide (Aime et al. 2007; Bernicchia & Niemelä 1998; Buchanan & Ryvarden 1988; Dai et al. 2002; Gilbertson & Hemmes 2004; Jia & Cui 2011; Læssøe & Ryvarden 2010; Lindblad & Ryvarden 1999; Mata & Ryvarden 2010; Pieri & Rivoire 1997; Rajchenberg 2000; Ryvarden & Iturriaga 2003; Suhara et al. 2003), 16 have been recorded in China (Cui & Jia 2011; Cui et al. 2008; Dai 2012; Dai et al. 2002, 2003, 2004, 2007a,b, 2009, 2011; Dai & Penttilä 2006; Jia & Cui 2011; Li et al. 2007, 2008; Wang et al. 2009, 2011; Yuan & Dai 2008; Yuan et al. 2006).

During a taxonomic study on *Ceriporia* in China, two species new to science were found that are described and illustrated here. An identification key to *Ceriporia* species in China based on Chinese material is provided.

Materials & methods

The studied specimens were deposited in herbaria as cited below. The microscopic procedure follows Dai (2010). Sections were studied at magnification up to ×1000 using

a Nikon Eclipse 80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. To present spore size variation, the 5% of measurements excluded from each end of the range are given in parentheses. Length of the basidiospore spines is not included in the measurements. Abbreviations include IKI = Melzer's reagent, IKI– = negative in Melzer's reagent, KOH = 10% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, CB– = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, and n = number of spores measured from a given number of specimens. Special color terms follow Petersen (1996).

Taxonomy

Ceriporia inflata B.S. Jia & B.K. Cui, **sp. nov.** FIG. 1

MycoBank MB 800809

Differs from other *Ceriporia* species by its large pores and hyphae that become swollen in KOH.

Type: China, Hainan Province, Qiongzhong County, Limushan Forest Park, on rotten angiosperm wood, 24.V.2008, Dai 9587 (**holotype**, BJFC).

Etymology: *inflata* (Lat.): referring to hyphae becoming swollen in KOH.

Fruitbody — Basidiocarps annual, resupinate, corky to brittle when dry, up to 13 cm long, 7 cm wide, and 3 mm thick at center. Pore surface white to cream when fresh, become buff, cinnamon-buff to clay-buff when dry; pores angular to irregular, 2–3 per mm; dissepiment thin, lacerate. Margin distinct, cream, thinning out, up to 0.8 mm, sometimes pores extend to the very edge, flocculent. Subiculum cream, corky when dry, up to 1 mm thick. Tubes concolorous with pore surface, brittle when dry, up to 2 mm thick.

Hyphal structure — Hyphal system monomitic; generative hyphae with simple septa, IKI–, CB+, swollen in KOH.

Context — Generative hyphae hyaline, thick-walled with a wide lumen, frequently branched at right angle, with frequent simple septa, more or less constricted at septa, interwoven, usually covered by small pale yellowish crystals, 4–8 μm in diam.

Tubes — Tramal hyphae hyaline, thin- to slightly thick-walled, frequently branched, with frequent simple septa, sometimes constricted at septa, subparallel along the tubes, covered by abundant tiny hyaline to pale yellowish crystals, 3.8–5 μm in diam; cystidia and cystidioles absent; basidia clavate, with four sterigmata and a basal simple septum, 12.9–19 × 3.8–4.2 μm; basidioles in shape similar to basidia, but smaller.

Spores — Basidiospores allantoid to cylindrical, hyaline, thin-walled, smooth, some slightly curved, IKI–, CB–, (4.5–)4.7–5.2(–5.3) × 2–2.4(–2.5) μm, L = 4.93 μm, W = 2.15 μm, Q = 2.29 (n = 30/1).

Type of rot — White rot.

Additional specimen examined — **China, Jiangxi Province**, Fenyi County, Dagang Mountain, on fallen trunk of *Alnus*, 17.IX.2008 Dai 10376 (BJFC).

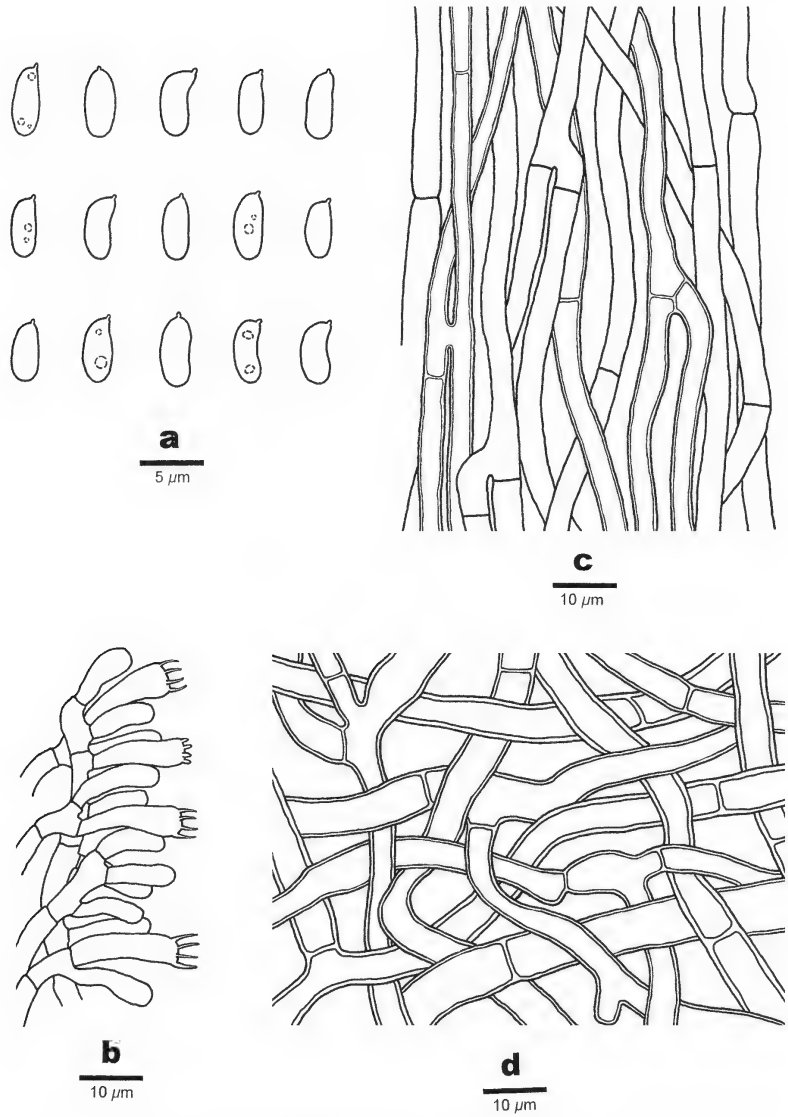

FIG. 1. *Ceriporia inflata* (holotype), microscopic structures.
a: Basidiospores. b: A section of hymenium. c: Hyphae from trama. d: Hyphae from subiculum.

REMARKS — *Ceriporia albobrunnea* Ryvarden & Iturr., recently described from Venezuela by Ryvarden & Iturriaga (2003), resembles *C. inflata* in similar pores (2–3 per mm, from the type) and basidiospores [4–5.1(–5.4) × (1.7–)1.9–2.2

(–2.4) μm, L = 4.6 μm, W = 2.05 μm, Q = 2.24 (n = 30/1), from the type)], but in *C. albobrunnea* tramal and subicular hyphae are very similar, while in *C. inflata* subicular hyphae are distinctly thick-walled and tramal hyphae are thin-walled. In addition, hyphae do not become swollen in KOH and dissepiments are thick and entire in *C. albobrunnea*, contrasting with hyphae that swell in KOH and thin lacerate dissepiments in *C. inflata.*

Ceriporia davidii (D.A. Reid) M. Pieri & B. Rivoire from France (Pieri & Rivoire 1997), has a similar hyphal but is differentiated from *C. inflata* by wider basidiospores [(4.2–)4.6–6(–6.5) × (2–)2.2–2.9(–3) μm, L = 5.08 μm, W = 2.58 μm, Q = 1.97 (n = 30/1, measured from the type)] that taper towards the apiculus and hyphae that do not swell in KOH.

Ceriporia jiangxiensis B.S. Jia & B.K. Cui, **sp. nov.** FIG. 2

MycoBank MB 800810

Differs from other *Ceriporia* species by its variably shaped basidiospores, presence of cystidia, distinctly thick-walled subicular hyphae, and occasional clamp connections.

Type: China, Jiangxi Province, Fenyi County, Dagang Mountain, on fallen angiosperm trunk, 21.IX.2009, Cui 7712 (**holotype**, BJFC).

Etymology: *jiangxiensis* (Lat.): referring to the local province name of Jiangxi.

Fruitbody — Basidiocarps annual, resupinate, brittle when dry, up to 8 cm long, 6 cm wide, and 2 mm thick. Pore surface cream, buff, cinnamon-buff when dry; pores angular to irregular, 3–4 per mm; dissepiment thin, entire to lacerate. Margin distinct, cream, cottony, up to 1.6 mm wide. Subiculum cream, corky when dry, up to 0.5 mm thick. Tubes concolorous with pore surface, brittle when dry, up to 1.5 mm thick.

Hyphal structure — Hyphal system monomitic; generative hyphae mostly with simple septa but rarely bearing clamp connections, IKI–, CB+, tissues unchanged in KOH.

Context — Generative hyphae hyaline, distinctly thick-walled with a wide lumen, frequently branched at right angle, interwoven, usually covered by fine hyaline to pale yellowish crystals, 3.5–10 μm in diam.

Tubes — Tramal hyphae hyaline, thin- to slightly thick-walled, frequently branched, interwoven, covered by abundant hyaline to pale yellowish crystals, 2.5–4.5 μm in diam; cystidia present, mycelioid, hyaline, thin-walled, 46–61.5 × 4–6 μm; basidia clavate, with four sterigmata and a basal simple septum, 11–22.2 × 3.6–5 μm; basidioles in shape similar to basidia, but slightly smaller.

Spores — Basidiospores variable in shape, allantoid, ellipsoid, cylindrical to oblong-ellipsoid, hyaline, thin-walled, smooth, IKI–, CB–, sometimes bearing one or two small guttules, (4.7–)4.8–5.8(–5.9) × (2–)2.1–2.7(–2.8) μm, L = 5.24 μm, W = 2.35 μm, Q = 2.23 (n = 30/1).

Type of rot — White rot.

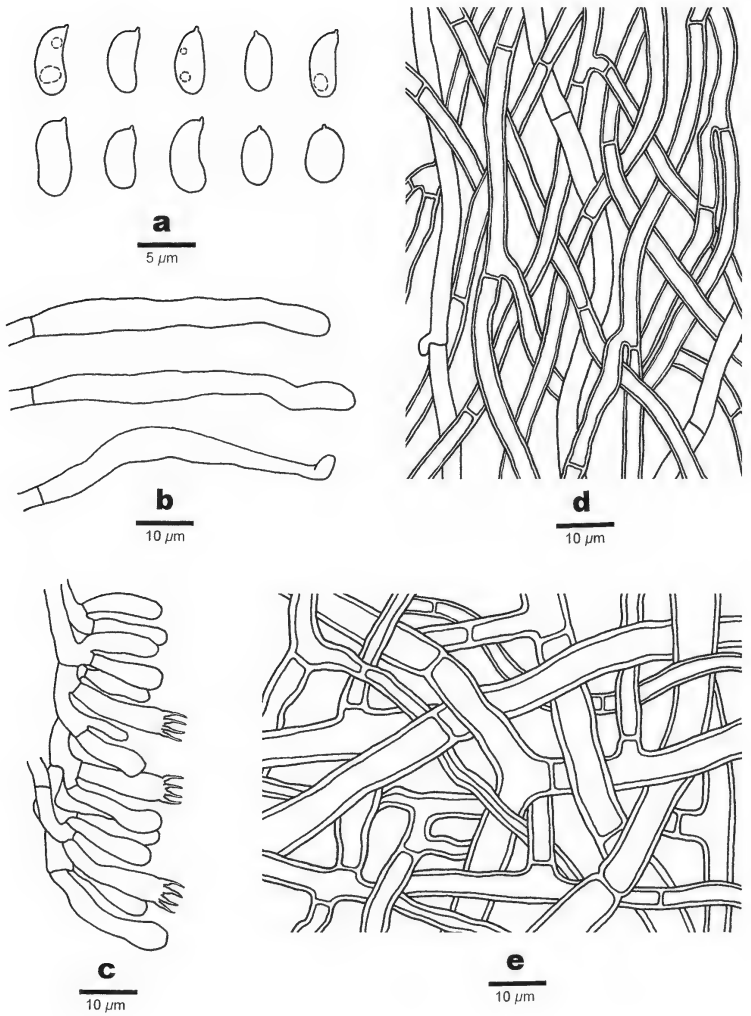

Fig. 1. *Ceriporia inflata* (holotype), microscopic structures.
a: Basidiospores. b: Cystidia. c: A section of hymenium.
d: Hyphae from trama. e: Hyphae from subiculum.

Remarks — Macroscopically, *Ceriporia jiangxiensis* is similar to *C. lacerata* N. Maek. et al., which differs in having broadly ellipsoid spores [4.25–5 × 2.5–2.75 μm (av. 4.5 ± 0.3 × 2.6 ± 0.1 μm, n = 20)] and lacking cystidia (Suhara et al. 2003).

Ceriporia camaresiana (Bourdot & Galzin) Bondartsev & Singer has similar basidiospores (5.5–6 × 2.3–2.8 μm) but is distinguished from *C. jiangxiensis* by larger pores (1–3 per mm), thin-walled subicular hyphae, and an absence of cystidia (Pieri & Rivoire 1997).

Ceriporia alba M. Pieri & B. Rivoire from France (Pieri & Rivoire 1997) shares similar pores (3–4 per mm) and cream-colored pore surface with *C. jiangxiensis*, but its holotype has longer basidiospores [(5.1–)5.2–6.3 × 2–2.8 μm, L = 5.84 μm, W = 2.35μm, Q = 2.49 (n = 30/1)], thin- to slightly thick-walled subicular hyphae, and no cystidia.

Other specimens examined: *Ceriporia alba*. FRANCE, Vernai, In arboretis, Forêt de la Joux, Jura, Gallia. Ad lignum angiospermarum, 26.V.1995, Rivoire 1078 (TYPE, LY).

C. albobrunnea. VENEZUELA, Estado Bolivar, Sifontes, Tumerermo, Carretera Tumerermo Bochinche Camp. Maderero de Lut., on hardwood. 17.XI.1994, Ryvarden 35238 (TYPE, O).

C. davidii. FRANCE, Orlienas. 3.I.2007, Rivoire 3052 (TYPE, LY).

Key to species of *Ceriporia* in China

1. Hyphal system dimitic ..... ***C. totara*** (G. Cunn.) P.K. Buchanan & Ryvarden
1. Hyphal system monomitic 2

2. Hyphae swollen in KOH ..... ***C. inflata***
2. Hyphae unchanged in KOH 3

3. Cystidia present 4
3. Cystidia absent 7

4. Pores 1–2 per mm ..... ***C. mellea*** (Berk. & Broome) Ryvarden
4. Pores 3–5 per mm 5

5. Spores >2 μm wide ..... ***C. jiangxiensis***
5. Spores <2 μm wide 6

6. Pores pinkish buff when dry; spores oblong-ellipsoid, <5 μm long ..... ***C. nanlingensis*** B.K. Cui & B.S. Jia
6. Pores dark brown when dry; spores allantoid, >5 μm long. ..... ***C. purpurea*** (Fr.) Donk

7. Spores >8 μm long. ..... ***C. reticulata*** (Hoffm.) Domański
7. Spores <8 μm long. 8

8. Spores >2.5 μm wide 9
8. Spores <2.5 μm wide 10

9. Spores ellipsoid to broadly ellipsoid, tramal hyphae parallel ..... ***C. lacerata***
9. Spores cylindrical to allantoid, tramal hyphae interwoven ..... ***C. camaresiana***

10. Spores allantoid 11
10. Spores ellipsoid to cylindrical, or cylindrical but a little curved 13

11. Spores narrowly allantoid, not tapering. ..... ***C. spissa*** (Schwein.) Rajchenb.
11. Spores allantoid, tapering towards apiculus 12

12. Pores cream, cinnamon, orange, green, 3–6 per mm; spores mostly >4 µm long ..... ***C. viridans*** (Berk. & Broome) Donk
12. Pores salmon, clay-pink to brownish vinaceous, 5–8 per mm; spores mostly <4 µm long .. ***C. aurantiocarnescens*** (Henn.) M. Pieri & B. Rivoire

13. Spores cylindrical, a little curved, mostly >4 µm long.....14
13. Spores ellipsoid to cylindrical, not curved, mostly <4 µm long 15

14. Pores rose-pink when fresh; tramal hyphae fairly thick-walled, frequently branched ..... ***C. tarda*** (Berk.) Ginns
14. Pores cream when fresh; tramal hyphae thin-walled, rarely branched .... ***C. davidii***

15. Pores sulphur; spores ellipsoid ..... ***C. sulphuricolor*** Bernicchia & Niemelä
15. Pores cream, orange or purple; spores cylindrical to oblong-ellipsoid 16

16. Pores orange or purple when fresh, 2–3 per mm; subicular hyphae mostly >6 µm in diam ..... ***C. excelsa*** (S. Lundell) Parmasto
16. Pores cream when fresh, 3–6 per mm; subicular hyphae <6 µm in diam.....17

17. Pores 3–4 per mm; tramal hyphae distinctly thick-walled, interwoven ..... ***C. crassitunicata*** Y.C. Dai & Sheng H. Wu
17. Pores 4–6 per mm; tramal hyphae thin- to fairly thick-walled, parallel ..... ***C. alachuana*** (Murrill) Hallenb.

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New *Candelariella* records for Turkey

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Abstract — Three species of *Candelariella* — *C. aggregata*, *C. plumbea*, and *C. rosulans* — are reported for the first time from Turkey.

Key words — *Ascomycota*, lichenized fungi, biodiversity, disjunct distribution

Introduction

Studies to determine biodiversity of lichenized fungi in Turkey have an extremely short history, although John (2004) cited 360 papers listing lichens from the country. In the last ten years, lichenological research has been rather intensive and has yielded numerous new Turkish records (e.g. Güvenç 2002; Öztürk & Güvenç 2003; Breuss & John 2004; John & Breuss 2004; Halıcı et al. 2005; Tufan et al. 2005; Güvenç et al. 2006; John & Türk 2006; Halıcı & Aksoy 2006; Halıcı et al. 2007a; Candan & Türk 2008; Yazıcı et al. 2008; Halıcı & Güvenç 2008; Halıcı & Aksoy 2009; Kocakaya et al. 2009; Kınalıoğlu 2009a; Kınalıoğlu 2009b; Yazıcı et al. 2010; Halıcı et al. 2010). Approximately 1200 lichenized fungi are now known from Turkey but, considering its size and diversity of phytogeographical regions and habitats, at least 2000 species might be present in the country (Halıcı et al. 2007b).

The lichenized fungal genus *Candelariella* includes species with 8- or polyspored asci of the "*Lecanora*"-type, biatorine or lecanorine apothecia, and a secondary chemistry with pulvinic acid and derivates. Of the approximately 50 species described worldwide (Westberg 2004), only 10 are known in Turkey (e.g. Breuss & John 2004; Candan & Türk 2008; Güvenç et al. 2006; Halıcı & Güvenç 2008; Halıcı & Aksoy 2009). With this report of three new records for Turkey, the number of *Candelariella* species in the country reaches 13. A modern revision of this genus will most likely increase this number.

Material & methods

The specimens are deposited in the lichen herbarium of Erciyes University, Biology Department (Kayseri, Turkey). They were examined by standard microscopic techniques. Hand-cut sections were studied in water, potassium hydroxide (KOH) and Lugol's solution (I). Measurements were made in water. When measuring the ascospores, 50 ascospores from 5 different apothecia were measured; only the ascospores outside the asci were measured. The descriptions summarized below for each species are our descriptions of the Turkish specimens.

Taxonomy

Candelariella aggregata M. Westb. Fig. 1A–B

Original description — Westberg (2007).

Thallus granular, distinct, yellow, granules scattered and obscured by the aggregated apothecia, K–, C–, Pd–. Apothecia lecanorine, rounded to irregular, in proper margin isodiametric cells of 3–4 µm present. Hymenium hyaline, 60–65 µm (n = 5). The algal layer is more or less continuous below the hypothecium. Asci clavate, 8-spored, ascospores simple, hyaline, ellipsoid, 13.5–17 × 5.5–6.5 µm (n = 50).

New record for Turkey. The specimen from Antalya was collected on plant debris with *Caloplaca stillicidiorum*. *Candelariella aggregata* was described from North America on mosses and plant debris, often on *Selaginella* tufts. It is also known from Alaska and northern Canada in arctic-alpine or steppe-like areas (Westberg 2007). Westberg (2007) stated that *C. aggregata* might possibly be a circumpolar species, although at the time it was known only from North America. The species has since been reported from Europe (Urbanavichus & Urbanavichene 2008, Spinelli 2011, Westberg & Clerc 2012), collected in alpine habitats in Romania (CBFS JV3754), included in the Russian checklist (Urbanavichus 2010), and from Asia (Westberg & Sohrabi 2012).

Material examined: **TURKEY. Antalya**, Alanya, Gevne valley, Şeker Pınarı Position, calcareous rocks in *Pinus nigra* forest, 36°45′19″N 32°27′69″E, alt. 1350 m, 25.09.2009, M.G. Halıcı & M. Kocakaya (MGH 7850); **Van**, Lake Van, SW of Bayramlı, limestone rocky outcrops near coast, 38°56′38″N 43°09′05″E, alt. 1680 m, 11.05.2007, J. Vondrák (CBFS JV8579).

Candelariella plumbea Poelt & Vězda Fig. 1C–D

Original description — Poelt & Vězda (1976).

Thallus grayish, but sometimes partly yellow pigmented, granulate to squamulose, very well-developed. Isidia-like protuberances present. Apothecia 0.2–0.5 mm (n = 5), with a yellowish to grey apothecial margin. Hymenium 65–70 µm high (n = 5). Asci 8-spored. Ascospores straight to slightly curved, 13.5–16(–18.5) × 6–9 µm (n = 50).

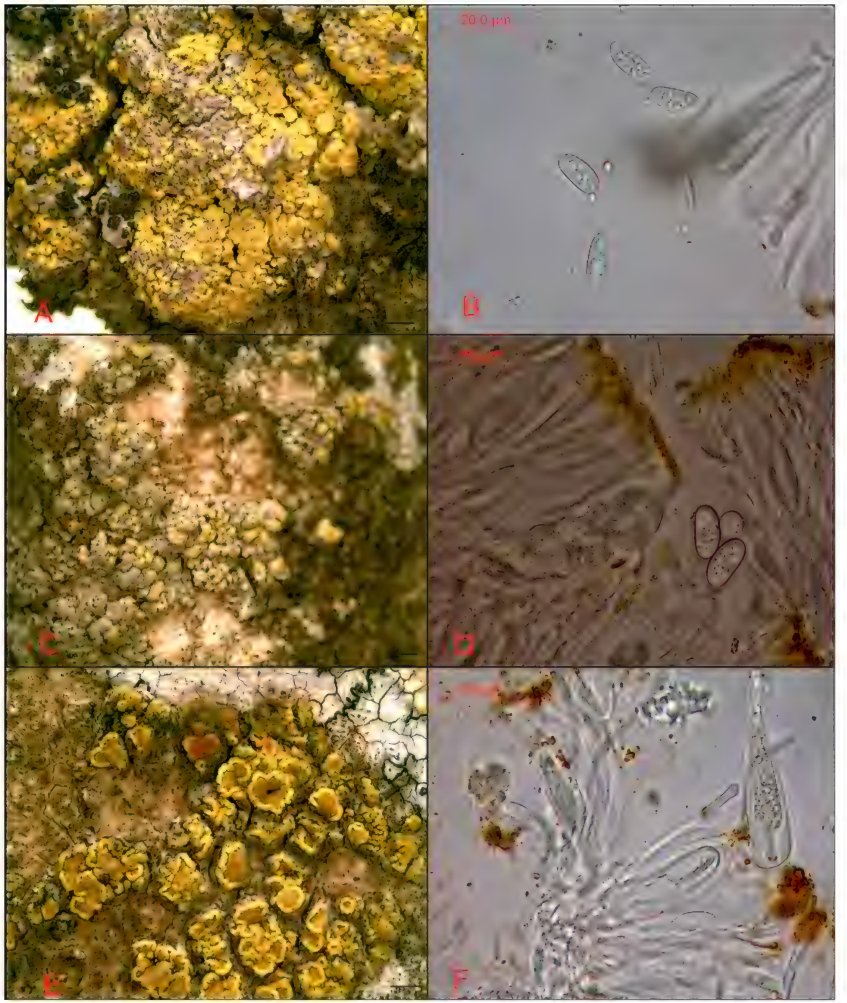

Fig. 1. ***Candelariella aggregata***: A, Thallus; B, Ascospores. ***C. plumbea***: C, Thallus; D, Ascospores. ***C. rosulans***: E, Thallus; F, Paraphyses, asci and ascospores. Scale bars: A, C, E = 3 mm.

New record for Turkey. Both specimens, collected from dolomite rocks in the southern part of Turkey, are obviously lichenicolous on *Staurothele areolata*, at least in the young stage of their development.

Candelariella plumbea was described from lowlands at about 50 m altitude in Romania (Poelt & Vězda 1976). According to Nimis (2003), this species is an arctic-alpine lichen. Vondrák et al. (2008) stated that specimens growing in alpine habitats have a less conspicuous thallus resembling *C. aurella* and are

possibly not conspecific with the xerothermic populations; our alpine collections from Turkey have rather well developed thalli. Ascospore measurements of the Turkish specimens differ from the measurements given in original description (14–18(–20) × 4.5–6 µm; Poelt & Vězda 1976), especially the spore width. Inconsistencies in ecology and morphology of various *C. plumbea* populations cannot be reasonably interpreted here.

Candelariella plumbea has previously been reported from Romania, Austria (Poelt & Vězda 1976), Bulgaria (Vondrák 2006), Italy (Nimis 2003), Greece (Spribille et al. 2006; Vondrák et al. 2008), Hungary (Vondrák et al. 2009) and Ukraine (Khodosovtsev 2005). It has also been reported from Colorado in North America (Weber 1990).

Materials examined: **TURKEY. İçel,** Çamlıyayla, Bolkar Mountain, Meydan plateau, calcareous and siliceous rocks, step vegetation, 37°24′5″N 34°33′55″E, alt. 2340 m, 23.09.2011, M.G. Halıcı & E. Kılıç (MGH 7851); **Kayseri,** Yahyalı, Aladağlar National Park, Gökoluk position 37°55′84″N 35°17′42″E, alt. 2340m, 11.07.2006, M.G. Halıcı & M. Kocakaya (MGH 2294); **Kirklareli,** Vize, Kıyıköy, North of the village, coastal rocks, 41°40′N 28°05′E, alt. 2-5 m, 08.07.2005, J. Vondrák (CBFS JV3077).

Candelariella rosulans (Müll. Arg.) Zahlbr. Fig. 1e–f

Original description — provided by Westberg (2007).

Thallus squamulose, lobes 1–1.5 µm, forming small rosettes; orange-yellow, K+ reddish. Apothecia common, lecanorine, thalline margin persistent, thick, crenulate, proper margin indistinct. Epihymenium yellow brown. Hymenium hyaline 60–90 µm (n = 5), subhymenial layers colorless, with oil droplets. Asci clavate, 8-spored, ascospores colorless, simple, not very well developed, 14–16 × 5–7 µm (n = 10).

New record for Turkey. The specimen was collected on calcareous rocks with *Caloplaca* spp., *Rinodina immersa*, and *Verrucaria nigrescens* in a shaded habitat. *Candelariella rosulans* is widely distributed in western North America (although not common on calcareous rocks; Westberg 2007) and has recently been found in Iran (Westberg & Sohrabi 2012). *Candelariella oleifera* H. Magn. from Central Asia is possibly synonymous (Westberg & Sohrabi 2012). Khodosovtsev (2005) described *C. rosulans* from southern Ukraine material; most characters fit well with *C. rosulans*, except that the Ukrainian ascospores are larger.

Material examined: **TURKEY. İçel**, Çamlıyayla, Ardıçlı village, *Pinus brutia* forest, 37°12′51″N 34°46′10″E, alt. 960m, 23.09.2011, M.G. Halıcı & E. Kılıç (MGH 7852).

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Lepiota himalayensis (*Basidiomycota, Agaricales*), a new species from Pakistan

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Abstract — A new *Lepiota* species from the Himalayan moist temperate forests in Pakistan is described and illustrated. The orangish-brown basidiocarp with dark blackish scales on the pileus, ellipsoid spores, narrowly clavate to clavate cheilocystidia, and the narrowly clavate to clavate nature of trichodermial elements of pileal covering are striking features of this species. The phylogenetic relationship with related species based on ITS-rDNA sequences is discussed.

Keywords — lepiotaceous fungi, mushroom diversity, phylogeny, rDNA

Introduction

The Himalayan moist temperate forests of Pakistan are distinguished by the luxurious vegetation of conifers and deciduous trees. In these forests, located at elevations of 1370–3050 m, maximum summer temperatures vary from 10.7–18°C, rainfall averages 59.3 cm, and humidity ranges up to 57% (Champion et al. 1968). Most of the mushrooms are still to be identified, even though Himalaya is one of the twenty-five world biodiversity hotspots (Myers et al. 2000).

Lepiota (Pers.) Gray (*Agaricales, Basidiomycota*) is an important and diversified genus comprising more than 400 species (Kirk et al. 2008, Liang &Yang 2011). This genus is characterized by a scaly pileus, free lamellae, partial veil in the form of annulus, a universal veil, and smooth, white, dextrinoid spores; most species have clamp connections (Vellinga 2001, Kumar & Manimohan 2009). Lepiotaceous fungi are very common in the forests of Pakistan, and of the 21 *Lepiota* species thus far reported from this country (Ahmed 1980, Shibata 1992, Murakami 1993, Sultana et al. 2011), 12 species are known from its Himalayan moist temperate forest (Ahmed et al. 1997, Sultana et al. 2011). During fieldwork in this area, a new species of *Lepiota* was collected from a

forest dominated by *Abies pindrow* (Royle ex D. Don) Royle. We describe it here as new and compare it with related species.

Materials & methods

Basidiocarps were carefully dug with the help of a knife and photographed in the field. Collected material was characterized morpho-anatomically and molecularly. Basidiocarp descriptions use the terminology of Vellinga (2001) and colors were determined and coded according to Anon (1975). Basidiocarp sections were stained with Congo Red and Melzer's reagent. Twenty-five basidiospores and 20 each of basidia, cheilocystidia, pileal elements, and stipe elements were measured from one basidioma. Abbreviations include: avl = average length, avw = average width, Q = length / width of basidiospore. Drawings were made using a camera lucida attached to the compound microscope. The dried specimen was deposited in the LAH Herbarium, Department of Botany, University of the Punjab, Lahore.

For molecular analysis, dried material was ground in liquid nitrogen, placed in 2% CTAB buffer, and DNA was extracted according to Porebski et al. (1997). The rDNA ITS regions were amplified using universal primer pair ITS1F and ITS 4 (White et al. 1990, Gardes & Bruns 1993). PCR was performed in 25 µL reaction volumes according to Gardes & Bruns (1993). PCR product of the ITS-amplified region containing ITS-1, 5.8 and ITS-2 was directly sequenced in both directions using the same pair of amplification primers (Macrogen, Korea). Nucleotide sequence comparisons were performed with Basic Local Alignment Search Tool (BLAST) network services using National Center for Biotechnology Information (NCBI), USA database. For further phylogenetic analysis and alignment of sequence, closely related sequences were retrieved from GenBank. Sequence alignments and phylogenetic analysis were performed using Molecular Evolutionary Genetics Analysis (MEGA) software (Tamura et al. 2011). Maximum Likelihood (ML) method was based on the Jukes-Cantor model of nrITS sequences using Nearest-Neighbor-Interchange (NNI) as ML heuristic search method. Phylogeny was tested by bootstrap value of 1000 replicates. Nucleotide sequence of *L. himalayensis* was submitted to European Molecular Biology Laboratory (EMBL) database and is available in GenBank (HE614898).

Taxonomy

Lepiota himalayensis Razaq & Khalid, **sp. nov.** FIGS 1, 3

MYCOBANK MB 563941

Differs from *Lepiota farinolens* by its larger basidiocarps, its smaller basidiospores, and its narrowly clavate to clavate cheilocystidia.

TYPE: Pakistan, Khyber Pakhtunkhwa, Himalayan Moist Temperate Forests, Khanspur, at 2250 m a.s.l., solitary, on moist ground under *Abies pindrow*, 23 August 2010, Abdul Razaq KP-63 (**Holotype**, LAH 230810; GenBank nrITS sequence HE614898).

ETYMOLOGY: The specific epithet refers to the general collection area of the type.

PILEUS 4 cm diam., campanulate to plano-convex, cinnamon (5.2YR/5.4/7.7) to umber (7.OYR/3.7/5.8) with fibrillose surface and scaly covering; scales dark

FIG. 1: *Lepiota himalayensis* A. Basidiocarp with prominent pileus scales. B. Reverse side of basidiocarp showing white lamellae. Scale Bars: A = 2 cm; B = 1.5 cm.

brown to blackish; central disc obtuse to slightly umbonate, distinguished from rest of pileus having black and prominent scales that are more or less uplifted and prominent; margins dentate, at maturity fragile and broken; context moderately thick, white. LAMELLAE free, crowded, white to cream (10YR8/4), two tiers of lamellulae alternating with lamellae. STIPE 6.0 × 0.6 cm, centrally attached, cylindrical and slightly tapering towards apex, orange-brown (7.5 YR 5/6; 5 YR4–5/6); surface scaly, scales brown and more prominent on lower part of the stipe below the annulus, above annulus smooth; with white hyphal mass at the base, annulus rudimentary, non-persistent. ODOR none. TASTE not recorded.

Basidiospores 6.7–8.3 × 3.0–4.0 µm, avl × avw = 7.4 × 3.5 µm, Q = 2.0–2.2, oblong, internal contents greenish, brown in Melzer's reagent. BASIDIA 23.5–27.7 × 8–9.7 µm, clavate to tapering towards base, with oil-like contents. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA hyaline, narrowly clavate to clavate, 19–28 × 5–10.5 µm. PILEUS covering a trichodermium with erect or ascending septate terminal elements, 53.5–99.5 × 2.5–7.5 µm, narrowly clavate to clavate without any shorter elements at the base of longer ones, light brown to hyaline. STIPE covering a cutis with occasional trichodermial patches of clavate terminal elements 42.5–127.5 × 8.0–9.0 µm, hyaline. CLAMP CONNECTIONS present.

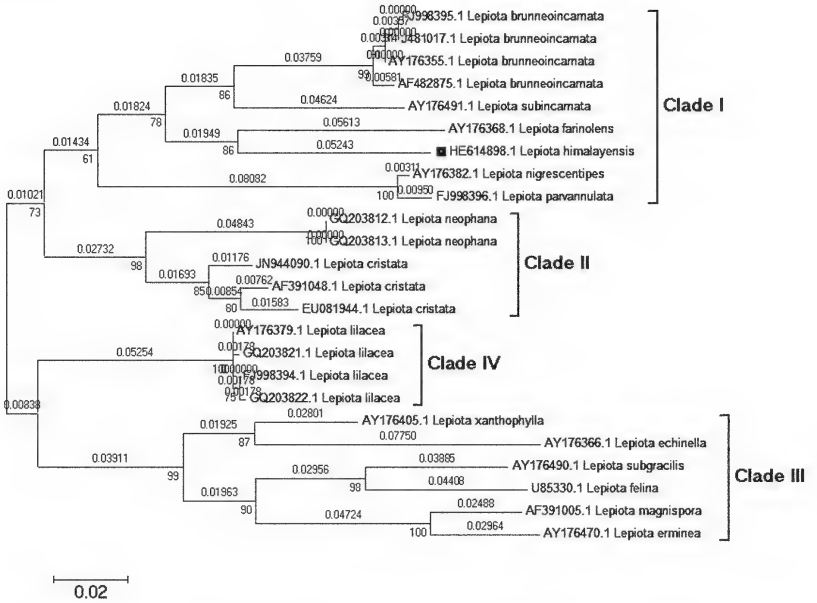

FIG. 2: Phylogenetic relationship of *Lepiota himalayensis* with other members of *Lepiota* based on Maximum Likelihood method inferred from nrITS sequences. Bootstrap values based on 1000 replicates are shown below the branches and below 50 are not shown. Branch length is shown above each branch. The topology of the tree based on Maximum Parsimony is same for *Lepiota himalayensis*. The analysis involved 30 sequences. All positions containing gaps and missing data were eliminated. There were a total of 649 positions in the final dataset.

Molecular description and phylogenetic analysis

When amplified, the target region of the fungal genomic DNA of *Lepiota himalayensis* generated fragments of approximately 750bp. Initial BLAST sequence analysis revealed a maximum sequence match with *L. brunneoincarnata* Chodat & C. Martín (GenBank FJ481017, FJ998395, AY176355). The top 100 sequence matches in the BLAST analysis belong to *Lepiota*, of which the topmost 35 sequences belonging to different *Lepiota* sections were included in the phylogenetic analysis.

An initial phylogenetic analysis shows that *L. himalayensis* clusters among sequences belonging to *Lepiota* sect. *Ovisporae* (J.E. Lange) Kühner. Additional published sequences from sects. *Ovisporae* and *Lepiota* were included in the alignment. In the maximum likelihood method (FIG. 2), four clades are formed, all members of sect. *Ovisporae* without short elements at the base of the long cells in the pileus covering clustered together in clade I. In this clade *L. farinolens* Bon & G. Riousset is closely related to *L. himalayensis*. *Lepiota*

subincarnata J.E. Lange and *L. brunneoincarnata* cluster together as a sister clade to *L. himalayensis* and *L. farinolens*. All taxa in this clade are distinguished by having only long pileal elements. *Lepiota parvannulata* (Lasch) Gillet and *L. nigrescentipes* G. Riousset form a sister clade to sect. *Ovisporae*. Additionally, taxa with a pileal covering composed of longer elements with shorter elements at the base of the longer ones cluster together in a separate clade (Fig. 2, Clade III), while taxa with a hymeniform pileal covering cluster together in Clade II. All sequences of *L. lilacea* Bres. form the separate clade IV. According to our phylogenetic analyses, the close relatives of *L. himalayensis* are *L. farinolens*, *L. subincarnata,* and *L. brunneoincarnata.*

Discussion

Lepiota himalayensis is characterized by orange-brown basidiomata with dark black squamules on the pileus, a trichodermial pileus covering composed of light brown to hyaline and elongate clavate elements, oblong spores, and narrowly clavate to clavate cheilocystidia. *Lepiota himalayensis* can be placed in *L.* sect. *Ovisporae* based on the trichodermial pileal covering and oblong basidiospores shorter than 10 µm (Singer 1986, Vellinga 2001, Kumar & Manimohan 2009).

Occurrence of non-persistent annulus and scales on lower part of the stipe bring *L. himalayensis* close to *L. helveola* Bres. and *L. pallidiochracea* J.F. Liang & Zhu L. Yang. However, the grayish red to reddish stipe and the two types of elements in *L. helveola* (Kosakyan et al. 2008) distinguishes that species from *L. himalayensis.* Although the basidiospores are similar in size (7–8 × 3.5–4 µm in *L. helveola*), the colourless spores in *L. helveola* contrast with the greenish colour in our species. Liang & Yang (2011) described variable cheilocystidia and apically attenuate pileal elements for *L. pallidiochracea* that distinguish it from *L. himalayensis.*

Four distinct clades were formed in the phylogenetic analysis. Clade I comprises sect. *Ovisporae* plus *L. parvannulata* and *L. nigrescentipes*. The position of these two species was not clear in Vellinga's (2003) phylogenetic tree. *Lepiota himalayensis* groups with *L. brunneoincarnata*, *L. subincarnata*, and *L. farinolens* in our maximum likelihood nrITS analysis (Fig. 2, Clade I) and lies in Vellinga's clade 2. The trichodermial pileus coverings of *L. brunneoincarnata* and *L. himalayensis* are comparable but the spore size (8–10.5 × 4–6 µm) and vinaceous blackish brown pileus colour distinguishes *L. brunneoincarnata* (Courtecuisse 1999). In the same clade *L. subincarnata* is separated by its orange-white pileus and smaller spore size (4.5–7.5 × 3–5 µm) (Kumar & Manimohan 2009). Molecular analysis showed a close relationship between *L. farinolens* and *L. himalayensis* but they differ morphologically. According to Salom & Siquier (2001), *L. farinolens* has smaller basidiocarps (15–25 mm), larger basidiospores (7.2–9.6(–11.2) × 4.8–5.4(–6) µm), variably

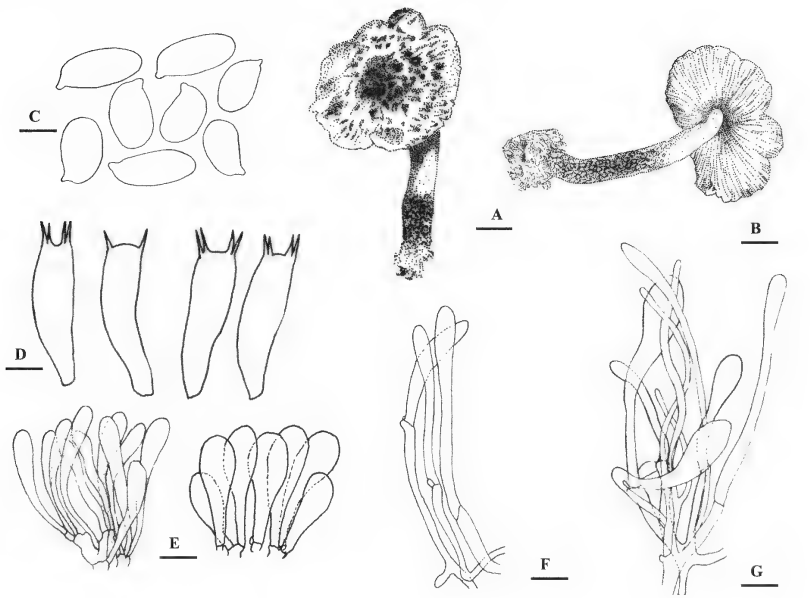

FIG. 3: *Lepiota himalayensis*. A–B. Basidiocarp. C. Basidiospores. D. Basidia E. Cheilocystidia. F. Stipe covering. G. Pileal covering elements. Scale bars: A–B = 1 cm; C = 3.5 µm; D = 6 µm; E = 13 µm; F = 21 µm; G = 16 µm.

shaped (cylindrical claviform, fusiform) cheilocystidia, and a single type of pileal element with thickened apices. Clade III contains those *Lepiota* species of sect. *Ovisporae* and sect. *Lepiota* that are characterized by longer pileal elements with an under-layer of shorter ones. Vellinga (2003) recognized these species as belonging to a polyphyletic clade containing species with fusiform, 'sphenisciform', and oblong spores.

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Phytophthora castaneae, the correct name for *P. katsurae* nom. nov. superfl.

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Abstract — *Phytophthora katsurae* was proposed as a nom. nov. for *P. castaneae* on the assumption that the replaced name was an illegitimate later homonym. This assumption was based on the invalid nomen nudum publication of "*Phytophthora castaneae*" in a host–pathogen index as a synonym of *Mycelophagus castaneae*, and an erroneous interpretation of Clements & Shear's listing of the type of the genus *Mycelophagus*. There is no valid earlier homonym. *Phytophthora castaneae* is the correct legitimate name for the taxon causing trunk rot of *Castanea crenata*, and *P. katsurae* is an illegitimate superfluous name.

Key words — chestnut disease, ink disease, nomenclature, taxonomy

Introduction

In 1976, Katsura & Uchida described a new *Phytophthora* species, *P. castaneae*, causing trunk rot of *Castanea crenata* in Japan (Katsura 1976). Subsequently, Ko & Chang (1979) claimed that *P. castaneae* was an illegitimate later homonym, and published a replacement name, *P. katsurae*, which has been used uncritically in taxonomic and phytopathological literature since that time (Ko & Arakawa 1980, Ho 1981, Ooka & Uchida 1984, Stamps 1985, Chang & Shu 1988, Liyanage & Wheeler 1989, Stamps et al. 1990, Oudemans & Coffey 1991, Uchida et al. 1992, Erwin & Ribeiro 1996, Elliott et al. 2004, Ristaino 2011). In this paper, I survey the relevant literature and demonstrate that Ko & Chang were mistaken — there is no earlier homonym and the correct name for this taxon is the legitimate original name, *P. castaneae*.

Ko & Chang's major error

Ko & Chang (1979: 841) presented a plausible case for the illegitimacy of *P. castaneae* Katsura & K. Uchida as a later homonym, but the basis of their case was the assumption that "The name of the type species [of *Mycelophagus*] was

consequently changed to *Phytophthora castaneae* (Mangin) Clements et Shear (7)." The referral of this citation to their LITERATURE CITED (7) [= MacFarlane (1968)] is puzzling, since MacFarlane (1968: 683) used the name "*Phytophthora castaneae*" in a host–pathogen index as a nomen nudum cross-reference to *Mycelophagus castaneae*, with no mention of Clements & Shear, or any other nomenclatural author. Moreover, Ko & Chang's attribution of the combination to Clements & Shear is a misreading or misunderstanding of Clements & Shear (1931: 241), where a list of synonyms of *Phytophthora* includes the monotypic genus *Mycelophagus* L. Mangin (Mangin 1903), with its type listed as "*M. castaneae* Mang." Clements & Shear did not make an explicit combination of the epithet in *Phytophthora*; and their citation of "*M. castaneae*" does not constitute a definite association of the epithet with the genus name *Phytophthora* or its abbreviation, as required for a valid combination (McNeill et al. 2006: Art. 33.1). The combination "*Phytophthora castaneae* (Mangin) Clements et Shear" is neither illegitimate (as Ko & Chang 1979 asserted, without explanation) nor invalid — it is non-existent!

The correct nomenclature

Phytophthora castaneae Katsura & K. Uchida, Trans. Mycol. Soc. Japan 17: 241. 1976.
≡ *Phytophthora katsurae* W.H. Ko & H.S. Chang, Mycologia 71: 841. 1979, nom. nov., nom. illegit. [superfluous].

In the absence of any earlier homonym, the name *P. castaneae* Katsura & K. Uchida is legitimate and the earliest available name for the taxon. Consequently, the nomen novum *P. katsurae* proposed by Ko & Chang (1979) is superfluous and therefore illegitimate (McNeill 2006: Art. 52.1).

Very few publications have avoided Ko & Chang's error and its erroneous nomenclatural consequences. Uchida (1976) and Newhook et al. (1978: 7) both presented the taxon as *P. castaneae*, but this predated the 1979 publication of *P. katsurae*. Index of Fungi 4(20): 514. 1980 recognised (in entries for *P. castaneae* and *P. katsurae*) that the *Phytophthora* combination based on *M. castaneae* was not proposed in Clements & Shear (1931), and stated that it was first proposed by MacFarlane (1968: 683) as an invalid combination lacking any reference to the author and place of publication of the basionym (McNeill et al. 2006: Art. 33.4). Miyata & Odagiri (1982a,b) used the name *P. castaneae,* and Dick (2001: 498, 499) listed *P. katsurae* as a synonym, cross-referenced to the main entry of *P. castaneae* [misspelt and misattributed as "*P. castanae* [sic] Katsura & S. [sic] Uchida"]. Index of Fungi 6(16): 868. 1998 listed *P. katsurae* as a superfluous synonym of *P. castaneae*.

The taxonomy and nomenclature of *Mycelophagus castaneae*

Mycelophagus castaneae L. Mangin, C.R. Hebd. Séanc. Acad. Sci., Paris 136: 472. 1903.

"*Phytophthora castaneae*" H.H. MacFarl., Rev. App. Mycol., Pl. Host–Path. Index vv. 1–40 (1922–61): 683. 1968, nom. inval. [no basionym author and reference].

"*Phytophthora castaneae*" W.H. Ko & H.S. Chang, Mycologia 71: 841. 1979, nom. inval. [accepted only as an illegitimate synonym of *M. castaneae*].

The French protologue of *M. castaneae* was reproduced and translated into English in Waterhouse (1970: 54–55) under the heading "Names not taken into *Phytophthora*." Waterhouse (1963: 18) concluded that the genus and species were "most probably *Phytophthora* sp. but impossible to tell from the description." Although its association with "ink disease of chestnut" in Europe (Blin 1922, Schell 1922, Waterhouse 1963) might suggest a possible relationship with either *P. cambivora* or *P. cinnamomi* (Erwin & Ribeiro 1996: 260, Vannini & Vettraino 2001, Vettraino et al. 2005), it is preferable to accept Waterhouse's expert opinion that *Mycelophagus castaneae* should be treated as a name of dubious application.

Index of Fungi 6(16): 868. 1998 interpreted the publication by Ko & Chang (1979) of the fictitious combination "*Phytophthora castaneae* (Mangin) Clements et Shear" as constituting an unintentional but valid combination by Ko & Chang, which would be an illegitimate later homonym of *P. castaneae* Katsura & K. Uchida. The Ko & Chang paper certainly appears to contain all the elements required for a valid comb. nov., although the full and direct basionym reference is made via a LITERATURE CITED reference, contrary to an ICBN recommendation (McNeill et al. 2006: Rec. 33A.1). However, Ko & Chang explicitly accepted the binomial only as an illegitimate synonym of *Mycelophagus castaneae*, which invalidates any putative new combination (McNeill et al. 2006: Art. 34.1(c)).

In a further concatenation of misinformation, Ristaino (2011) stated that *P. katsurae* was "a replacement name for *P. castaneae* (L. Mangin) Clements & Shear (1931) and for *P. castaneae* Katsura & Uchida (1976), which are both considered illegitimate names." Neither Ko & Chang (1979) nor any other author has ever suggested any taxonomic connection between Mangin's and Katsura & Ushida's species, the putative Clements & Shear combination is non-existent, and *P. castaneae* Katsura & K. Uchida is a legitimate name.

Acknowledgments

This paper is dedicated to the memory of my late colleague, Ross Beever, who first posed the question, and who subjected the arguments to his characteristically intense critical analysis and questioning. I thank Stan Bellgard and Bevan Weir (Landcare

Research, Auckland) for assistance with literature and for their comments and criticisms of an earlier draft, and Joost Stalpers (CBS, Utrecht) and Scott Redhead (Systematic Mycology and Botany, Agriculture and Agri-Food Canada, Ottawa) for acting as pre-submission referees.

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Studies on *Wrightoporia* from China 2. A new species and three new records from South China

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Abstract — During a taxonomic study on *Wrightoporia* from South China, four species new to China were collected: *W. cinnamomea*, *W. labyrinthina*, *W. ochrocrocea*, and a new species described as *W. biennis*. *Wrightoporia biennis* is characterized by a biennial growth habit, non- to weakly dextrinoid and distinctly narrow skeletal hyphae, abundant thick-walled gloeoplerous hyphae, presence of thin-walled cystidia, and asperulate basidiospores. Illustrations and descriptions of these species are provided based on the Chinese materials.

Key words — *Bondarzewiaceae*, polypore, taxonomy, wood-inhabiting fungi

Introduction

Wrightoporia Pouzar was established for the type species, *W. lenta* (Overh. & J. Lowe) Pouzar, by Pouzar (1966). The main characters for the genus are the resupinate to pileate basidiocarps, an annual to perennial growth habit, a monomitic to trimitic hyphal structure, and amyloid asperulate basidiospores (David & Rajchenberg 1987, Ryvarden 1982). Of the 40 species described or transferred to the genus worldwide (Hattori 2003, 2008; Ryvarden 2000), 15 have been recorded in China (Chen & Yu 2012; Cui & Dai 2006; Dai 2012; Dai & Cui 2006; Dai et al. 2011).

Wood-inhabiting fungi in southern China have been extensively studied, and many new polypores have been described recently (Cui & Dai 2011; Cui et al. 2009, 2010, 2011; Dai et al. 2010, 2011; Du & Cui 2009; Jia & Cui 2011; Li & Cui 2010). During taxonomic studies of polypores in southern China, one new species and three new Chinese records of *Wrightoporia* were identified from our collected samples. Their detailed descriptions and illustrations are given in this paper.

Materials & methods

Sections were studied microscopically according to Dai (2010) at magnifications ≤ 1000× using a Nikon Eclipse E 80i microscope with phase contrast illumination.

Drawings were made with the aid of a drawing tube. Microscopic features, measurements and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. Spores were measured from sections cut from the tubes. To present spore size variation, the 5% of measurements excluded from each end of the range are given in parentheses. Basidiospore spine lengths are not included in the measurements. Abbreviations include IKI = Melzer's reagent, IKI– = negative in Melzer's reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, CB– = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, and n = number of spores measured from given number of specimens. Special color terms follow Petersen (1996). The studied specimens were deposited in herbaria as cited below.

Taxonomy

Wrightoporia biennis Jia J. Chen & B.K. Cui, **sp. nov.** FIG. 1

MycoBank MB 800915

Differs from other *Wrightoporia* species by a biennial growth habit, hard resupinate basidiocarps with tiny pores, non- to weakly dextrinoid distinctly narrow skeletal hyphae, abundant thick-walled gloeoplerous hyphae, and thin-walled cystidia.

TYPE — China, Yunnan Province, Xi-Shuang-Banna, Mengla County, Wangtianshu Park, on fallen angiosperm trunk, 2.XI.2009, Cui 8506 (**holotype**, BJFC).

ETYMOLOGY — *biennis* (Lat.): referring to the biennial growth habit.

FRUITBODY — Basidiocarps biennial, resupinate, inseparable, hard corky upon drying, ≤10.5 cm long, 7 cm wide, 4 mm thick at center. Pore surface buff-yellow to fawn-brown when dry; pores round to angular, 6–9 per mm; dissepiments thin to slightly thick-walled, entire. Sterile margin distinct, yellowish to brown, corky, ≤5 mm wide. Subiculum buff to cinnamon-brown, corky, ≤3 mm thick. Tubes concolorous with the pore surface, hard corky, ≤1 mm long.

HYPHAL STRUCTURE — Hyphal system dimitic; generative hyphae with clamp connections; skeletal hyphae CB–, weakly dextrinoid near the tube mouths, otherwise IKI–; tissues becoming dark brown in KOH. Abundant oily substance present in trama and subiculum.

SUBICULUM — Generative hyphae frequent, hyaline, thin- to slightly thick-walled, moderately branched, partly encrusted with yellowish, irregular crystals, 1–5 μm in diam; skeletal hyphae common, hyaline to light orange, thick-walled with a narrow lumen, rarely branched, flexuous, interwoven, rarely encrusted with hyaline to yellowish, irregular crystals, 2–3 μm in diam; gloeoplerous hyphae present, thick-walled with granular to oily contents appearing refractive in phase contrast, 4–8 μm in diam.

TUBES — Generative hyphae infrequent, thin- to slightly thick-walled, frequently branched, partly encrusted with hyaline to yellowish, irregular crystals, 1–2.5 μm in diam; skeletal hyphae dominant, hyaline to light orange,

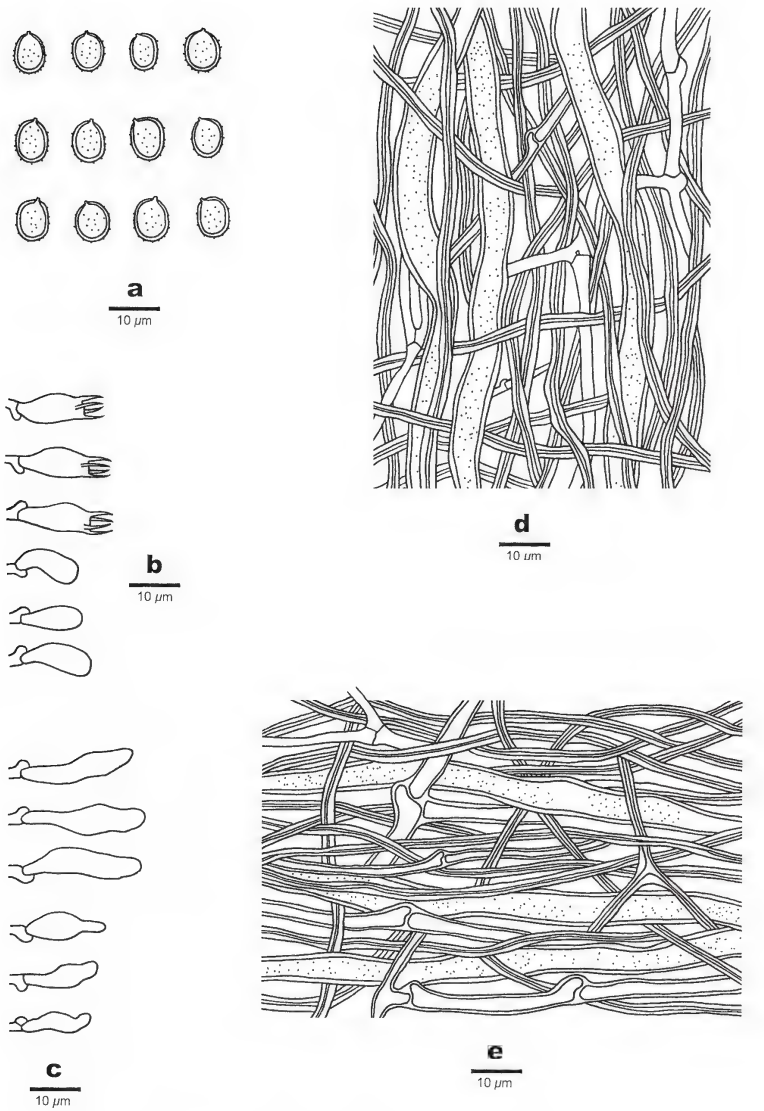

Fig. 1. *Wrightoporia biennis* (holotype), microscopic structures.
a: Basidiospores. b: Basidia and basidioles. c: Cystidia and cystidioles.
d: Hyphae from trama. e: Hyphae from subiculum.

thick-walled with a narrow lumen, rarely branched, flexuous, interwoven, sometimes encrusted with hyaline, irregular crystals, 1.5–3 µm in diam; gloeoplerous hyphae abundant, especially near the tube mouths, thick–walled

with granular to oily contents appearing refractive in phase contrast illumination, 5–9 µm in diam, embedded in the trama; cystidia clavate, hyaline, thin-walled, 20–25 × 4–6 µm, and fusoid cystidioles present, hyaline, thin-walled, 9–12 × 3–5 µm; basidia subclavate to barrel-shaped, bearing four sterigmata and a basal clamp connection, 12–17 × 5–7 µm; basidioles in shape similar to basidia, but slightly smaller.

Spores — Basidiospores subglobose to broadly ellipsoid, hyaline, thick-walled, finely asperulate, strongly amyloid, CB+, (3.2–)3.3–4(–4.1) × 2.6–3.5 (–3.6) µm, L = 3.64 µm, W = 3.06 µm, Q = 1.18–1.21 (n = 60/2).

Additional specimen examined — **China. Yunnan Province**, Xi-Shuang-Banna, Mengla County, Lvshilin Park, on fallen angiosperm trunk, 1.XI.2009, Cui 8457 (BJFC).

Remarks — *Wrightoporia biennis* resembles *W. micropora* Aime & Ryvarden (nom. illegit., non P.K. Buchanan & Ryvarden) by sharing resupinate basidiocarps, similar basidiospores (3–4 × 3 µm in *W. micropora*), but *W. biennis* differs in distinctly dextrinoid, wider (4–5 µm) skeletal hyphae and lacks both gloeoplerous hyphae and cystidia (Aime et al. 2007).

Wrightoporia neotropica Ryvarden may be confused with *W. biennis* by its resupinate basidiocarps and tiny pores (6–8 per mm in *W. neotropica*). However, *W. neotropica* has wider (4–6 µm) skeletal hyphae that are more or less parallel along the tubes, lacks both gloeoplerous hyphae and cystidia, and has subicular skeletal hyphae that are consistently even and without encrustations (Cui & Dai 2006, Ryvarden 2000).

Wrightoporia tropicalis (Cooke) Ryvarden also has hard basidiocarps and similar pores (6–8 per mm) and basidiospores (3–4 × 2–3 µm), but differs from *W. biennis* in wider (3–5 µm) skeletal hyphae that are partly inflated and thick-walled cystidia (Ryvarden & Johansen 1980).

Wrightoporia labyrinthina also has non- to weakly dextrinoid skeletal hyphae and abundant gloeoplerous hyphae. However, it is distinguished from *W. biennis* mainly by an annual growth habit, larger and irregular pores (1–2 per mm in the holotype), and lack of cystidia (Hattori 2008).

Wrightoporia cinnamomea Ryvarden, Nordic Journal of Botany, 2: 146, 1982 Fig. 2

Fruitbody — Basidiocarps annual, resupinate, soft when fresh, becoming tough upon drying; about 8 cm long, 6 cm wide, and 3 mm thick at centre; margin rhizomorphic, vinaceous brown. Pore surface cream to pale cinnamon; pores round to angular, 6–8 per mm; dissepiments thin, entire to lacerate. Subiculum buff to cinnamon-buff, soft cottony, ≤1 mm thick. Tubes concolorous with the pore surface, fibrous-tough, ≤2mm long.

Hyphal structure — Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae CB–, IKI–; skeletal hyphae in the trama partly inflated in KOH, ≤7 µm wide, otherwise unchanged in KOH.

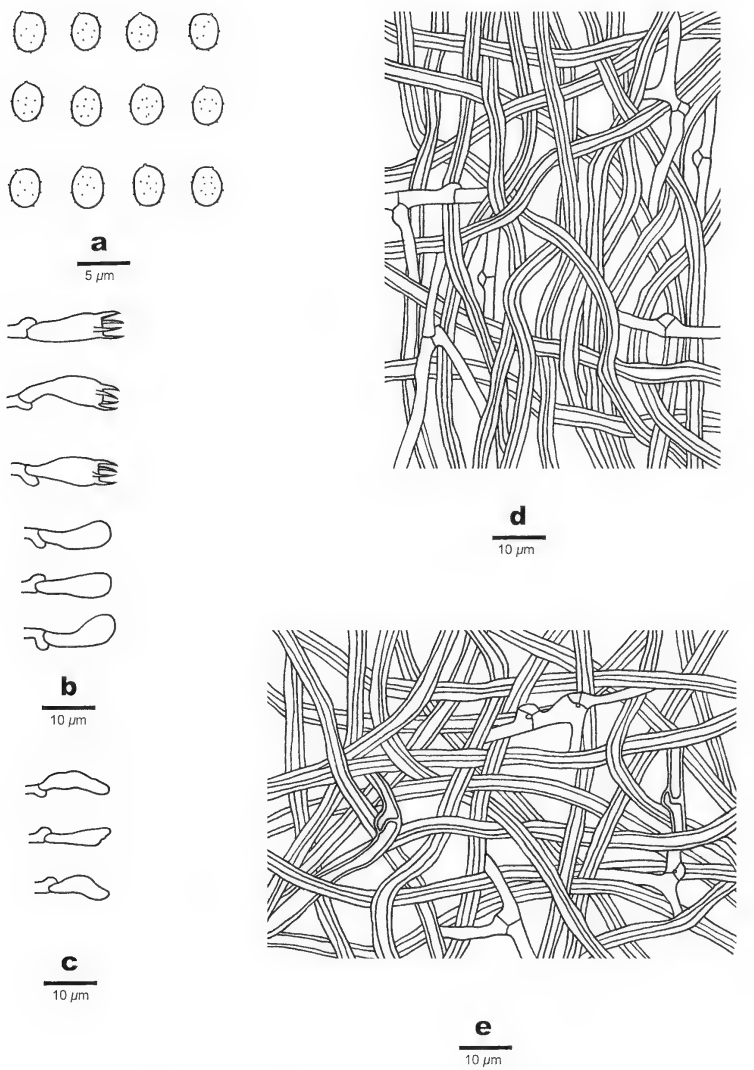

Fig. 2. *Wrightoporia cinnamomea* (Yuan 2201), microscopic structures.
a: Basidiospores. b: Basidia and basidioles. c: Cystidioles.
d: Hyphae from trama. e: Hyphae from subiculum.

Subiculum — Generative hyphae hyaline, thin-walled, frequently branched, 2–3 μm in diam; skeletal hyphae dominant, yellowish to brownish orange, thick-walled with a wide to narrow lumen, straight to flexuous, interwoven, sometimes encrusted with yellowish, irregular crystals, 2–5 μm in diam.

Tubes — Generative hyphae hyaline, thin- to slightly thick-walled, frequently branched, 2–3 μm in diam; skeletal hyphae dominant, hyaline to yellowish, thick-walled with a wide to narrow lumen, unbranched, straight to flexuous, interwoven, sometimes encrusted with yellowish, irregular crystals, 2–5 μm in diam; cystidia absent, but fusoid cystidioles present; basidia clavate, thin-walled, with four sterigmata and a basal clamp connection, 12–20 × 5–6 μm; basidioles in shape similar to basidia, but slightly smaller.

Spores — Basidiospores subglobose, hyaline, thin-walled, finely asperulate, strongly amyloid, CB–, 3–3.8 × 2.6–3 μm, L = 3.28 μm, W = 2.82 μm, Q = 1.16 (n = 30/1).

Specimens examined — **CHINA. Yunnan Province**, Lijiang, Yunshanping, on fallen trunk of *Abies*, 4.IX.2006, Yuan 2201 (IFP). **JAPAN. Chiba Prefecture**, Tokyo University Forest, Kiyosumi Forest Station, 24.VIII.1983, Ryvarden 21033 (O).

Remarks — *Wrightoporia cinnamomea* is easily identified by its cream to pale cinnamon pores, rhizomorphic basidiocarps, and non-dextrinoid skeletal hyphae. It is related to *W. africana* I. Johans. & Ryvarden, which also produces resupinate basidiocarps and similar (3–3.5 × 2.5–3 μm) basidiospores but which differs in slightly larger pores (5–6 per mm) and dextrinoid skeletal hyphae (Johansen & Ryvarden 1979; Ryvarden 1982).

Wrightoporia labyrinthina T. Hatt., Mycoscience 49: 59, 2008 Fig. 3

Fruitbody — Basidiocarps annual, resupinate to effused-reflexed, corky upon drying; about 4.8 cm long, 3 cm wide, and 2.5 mm thick at centre. Sterile margin distinct, pale orange, membranous, ≤2.5 mm wide. Pore surface pale orange to greyish brown; pores angular to sinuous, elongated to daedaleoid, 1–2(–3) per mm; dissepiments thin, entire to partly lacerate. Subiculum brownish orange, membranous, ≤0.5 mm thick. Tubes concolorous with pore surface, leathery, ≤2 mm long.

Hyphal structure — Hyphal system dimitic; generative hyphae with clamp connections; skeletal hyphae CB–, weakly dextrinoid or IKI–; tissues becoming dark brown in KOH.

Subiculum — Generative hyphae hyaline, thin-walled, moderately branched, 2–3 μm in diam; skeletal hyphae dominant, yellowish to orange, thick-walled with a wide to narrow lumen, unbranched, more or less flexuous, interwoven, 2–5.5 μm in diam; gloeoplerous hyphae present, ≤9 μm in diam.

Tubes — Generative hyphae hyaline, thin- to slightly thick-walled, occasionally branched, 1.5–2.5 μm in diam; skeletal hyphae dominant, yellowish to orange, thick-walled with a wide to narrow lumen, unbranched, flexuous, interwoven, 2–4.5 μm in diam; gloeoplerous hyphae present, unbranched, hyaline, ≤9 μm in diam. Cystidia absent, fusoid cystidioles present; basidia subclavate, bearing four sterigmata and a basal clamp connection, 12–15 ×

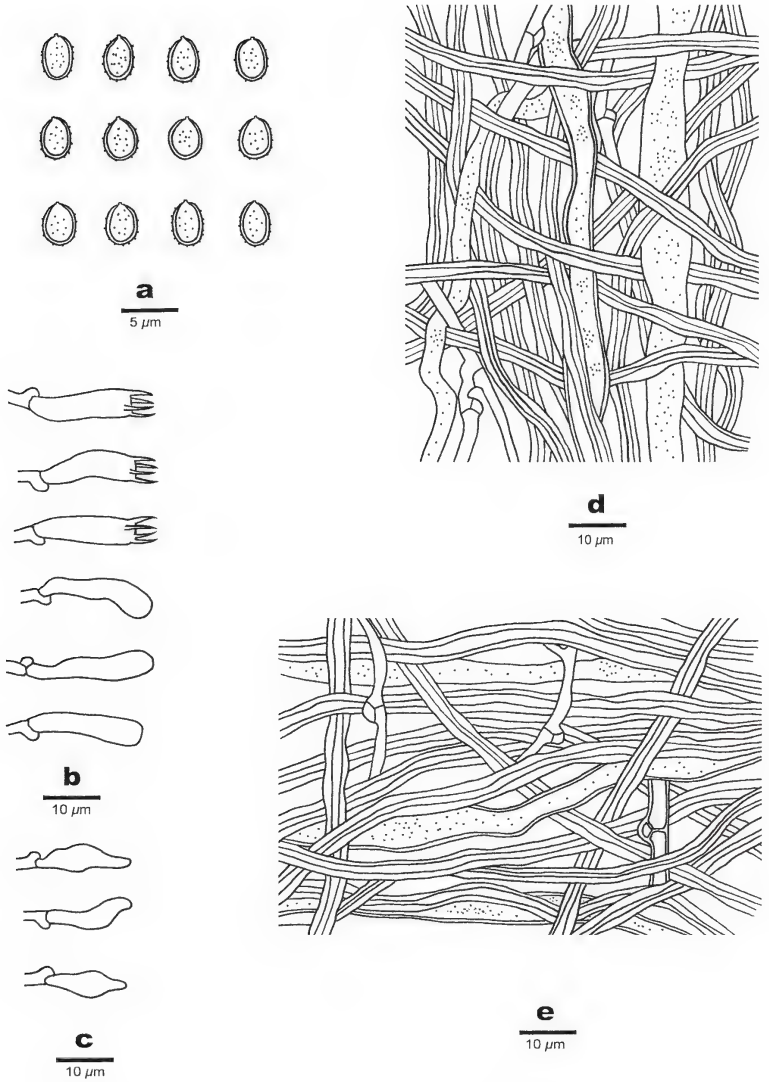

Fig. 3. *Wrightoporia labyrinthina* (Yuan 1475), microscopic structures.
a: Basidiospores. b: Basidia and basidioles. c: Cystidioles.
d: Hyphae from trama. e: Hyphae from subiculum.

3–3.5 µm; basidioles in shape similar to basidia, but slightly smaller.

Spores — Basidiospores ellipsoid to broadly ellipsoid, hyaline, slightly thick-walled, echinulate, amyloid, CB–, 3.6–4 × (2.7–)2.8–3 µm, L = 3.89 µm, W = 2.93 µm, Q = 1.33 (n = 30/1).

Specimens examined — **CHINA. Yunnan Province**, Xishuangbanna, Mangao Nature Reserve, on fallen angiosperm branch, 11.VIII.2005, Yuan 1475 (IFP). **JAPAN. Ibaraki Prefecture**, Kitaibaraki, Ogawa, on twig of hardwood, 30.IX.2003, F-20724 (holotype, TFM).

Remarks — *Wrightoporia labyrinthina* resembles *W. gyropora* (Corner) Stalpers in large, irregular pores but is distinguished by the leathery tough tubes and the presence of gloeoplerous hyphae. It is also similar to *W. pouzarii* A. David & Rajchenb. in the large pores, but *W. pouzarii* has pileate basidiocarps and lacks gloeoplerous hyphae (David & Rajchenberg 1987; Hattori 2003, 2008; Ryvarden 1975).

Wrightoporia ochrocrocea (Henn. & E. Nyman) A. David & Rajchenb., Canadian Journal of Botany, 65: 208, 1987 Fig. 4

≡ *Polyporus ochrocroceus* Henn. & E. Nyman, Monsunia 1: 145, 1899 ["1900"]

Fruitbody — Basidiocarps annual, effused-reflexed or pileate, hard corky upon drying; pileus broadly attached, semicircular to elongated, projecting ≤1 cm long, 2 cm wide, 3 mm thick at base. Pileal surface buff to slightly dark yellow-brown, azonate, not sulcate; margin obtuse. Pore surface straw-yellow to clay-buff; pores angular, 8–10 per mm; dissepiments thin, entire. Context darker than tubes, chrome-yellow to yellow-brown, soft cottony and easily compressed, ≤2 mm thick. Tubes concolorous with pore surface, fibrous-tough, ≤1 mm thick.

Hyphal structure — Hyphal system monomitic in the context, dimitic in the trama; generative hyphae bearing clamp connections; skeletal hyphae CB+, dextrinoid near the tube mouths, otherwise IKI–; tissues becoming dark brown in KOH.

Context — Generative hyphae hyaline to yellow, slightly thick-walled to thick-walled with a wide lumen, moderately branched, frequently encrusted with hyaline to yellowish, irregular crystals, 2–4 μm in diam.

Tubes — Generative hyphae hyaline to yellowish, thin- to slightly thick-walled, occasionally branched, occasionally encrusted with yellowish, irregular crystals, 1.8–4.5 μm in diam; skeletal hyphae dominant, yellowish to yellow, thick-walled with a wide to narrow lumen, unbranched, interwoven, 2–5 μm in diam. Cystidia and cystidioles absent; basidia subclavate to barrel-shaped, bearing four sterigmata and a basal clamp connection, 12–16 × 4–6 μm; basidioles in shape similar to basidia, but slightly smaller.

Spores — Basidiospores broadly ellipsoid, hyaline, slightly thick-walled, finely asperulate, amyloid, weakly CB+, (2.2–)2.3–3.1(–3.2) × (1.8–)1.9–2.3(–2.4) μm, L = 2.86 μm, W = 2.08 μm, Q = 1.38 (n = 30/1).

Specimens examined — **CHINA. Guangdong Province**, Heyuan, Daguishan Forest Park, on fallen angiosperm branch, 18.VIII.2011, Cui 10129 (BJFC). **THAILAND. Issan District**, Khao Yai National Park, near the fall, along the river, 11.VIII.1997, Núñez 1997 (O). **NEW GUINEA. Morobe District**, Bulolo, 5.XII.1967, leg. P. Wright (O).

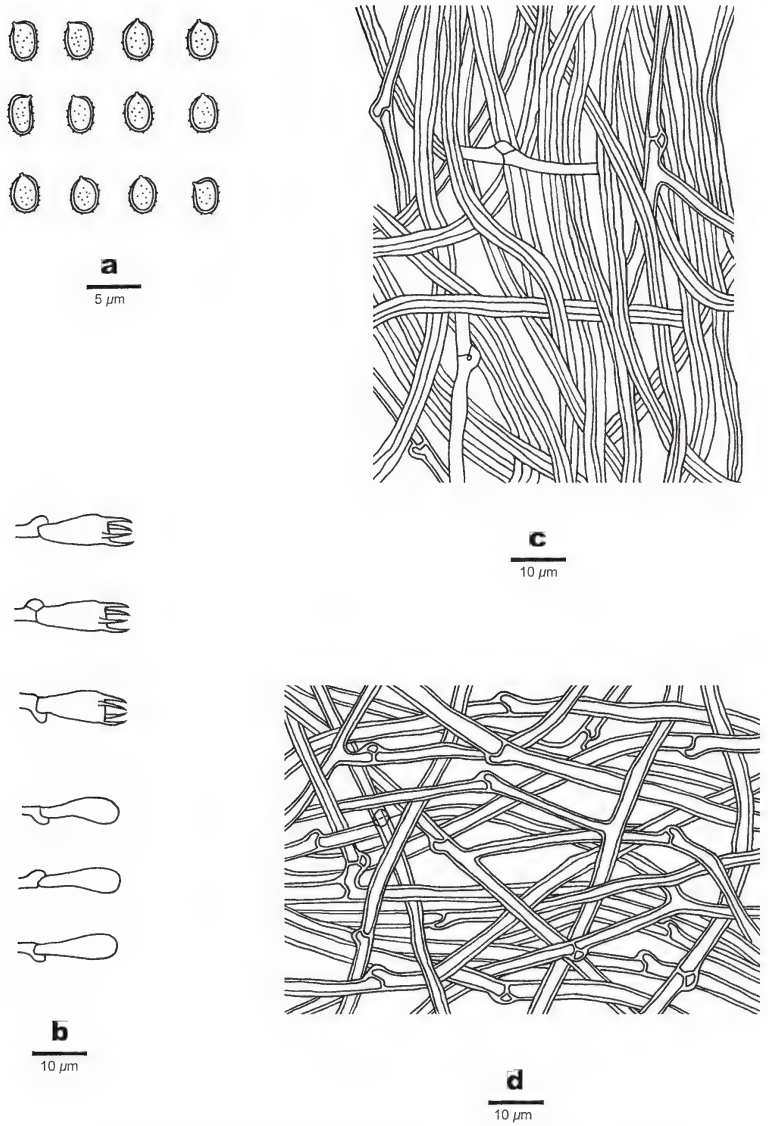

Fig. 4. *Wrightoporia ochrocrocea* (Cui 10129), microscopic structures.
a: Basidiospores. b: Basidia and basidioles. c: Hyphae from trama. d: Hyphae from context.

Remarks — *Wrightoporia ochrocrocea* is characterized by a dimitic trama and monomitic context and hyphae that are non- or slightly dextrinoid. *Wrightoporia trametoides* (Corner) Stalpers also produces hard corky basidiocarps and a

dimitic trama and monomitic context but differs from *W. ochrocrocea* in larger (3.5–4 × 2–2.5 μm) basidiospores (Ryvarden & Johansen 1980; Corner 1989; Hattori 2003).

Other specimens examined — ***Wrightoporia africana***. CAMEROON. Campo Province, Akok Lowland Rain Forest Reserve, 2.XII.1991, Ryvarden 30558 (O). UGANDA. Kanungu District, Bwindi Impenetrable Forest National Park, 5.VI.2003, Ipulet F1965 (O).

— ***W. gyropora***. BRUNEI. Borneo, Andulai Forest, 22.II.1959, on stump of old tree in the forest, leg. E.J.H. Corner (holotype, E).

— ***W. micropora***. GUYANA. Pakaraima Mountains, Upper Potaro River, 20 km east of Mt. Ayanganna, near confluence of Potaro River and Alukyadongbaru Creek, Paluway plot 3 in *Dicymbe corymbosa*-dominated forest, on underside of hardwood log, 18.V.2001, Aime 1521 (BRG, holotype, O).

— ***W. neotropica***. DOMINICAN REPUBLIC. La Vega province, Casabito, El Arroyazo, 29.V.1997, Ryvarden 40228 (O).

— ***W. pouzarii***. UGANDA. Kabale District, Bwindi Forest National Park, Ruhija, in Mature mixed Forest, on fallen rotting branches, 2.VI.2003, Ipulet 1883 (O). ZAMBIA. Chowo Forest, Nyika Plateau, 27.I.1983, J. Selander 736/7 (O).

— ***W. trametoides***. MALAYSIA. Johore, Sedili River, 22.V.1940, leg. E.J.H. Corner (holotype, E).

— ***W. tropicalis***. BELIZE. Orange Walk district, La Milpa Field Station, 24.X.2002, Ryvarden 45184 (O). Cayo District, Guacamayo Bridge, Mecal River, 1.XI.2002, Ryvarden 45363 (O). CHINA. Hainan Province, Lingshui County, Diaoluoshan Reserve, on root wood of *Dacrydium*, 23.XI.2002, Dai 4490 (BJFC).

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Diplomitoporus dilutabilis belongs to *Cinereomyces* (*Polyporales, Basidiomycota*)

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Abstract — The Brazilian polypore *Diplomitoporus dilutabilis* is combined in *Cinereomyces*, and compared with *C. lindbladii*. The species share similar irregular, amyloid, acyanophilous skeletal hyphae that have a wide lumen and dissolve in KOH. A brief description and drawings of the type of *C. dilutabilis* are provided.

Introduction

The genus *Cinereomyces* was described as monotypic (Jülich 1982: 396). Other authors have sought to widen the concept (Niemelä 2005, Spirin 2005) by including *Skeletocutis lenis* (P. Karst.) Niemelä and *S. vulgaris* (Fr.) Niemelä & Y.C. Dai in the genus. My co-workers and I subsequently revised the generic concept, accepting only the type species *Cinereomyces lindbladii* (Berk.) Jülich (Miettinen & Larsson 2011, Miettinen & Rajchenberg 2012).

When describing *D. dilutabilis*, Loguercio-Leite & Wright (1998) noted that the species closely resembles *Cinereomyces lindbladii*. I sought to verify this, and microscopic analysis of the type material from Santa Catarina, Brazil, confirmed that *D. dilutabilis* and *C. lindbladii* are indeed closely related.

Materials & methods

The reader is referred to Miettinen et al. (2006) for details on microscopy. The basic mounting medium used for descriptions and drawings was Cotton Blue.

Taxonomy

Cinereomyces dilutabilis (Log.-Leite & J.E. Wright) Miettinen, **comb. nov.** Pl. 1

MycoBank MB 564956

≡ *Diplomitoporus dilutabilis* Log.-Leite & J.E. Wright, Mycotaxon 68: 48, 1998.

Basidiocarp resupinate, light brownish with yellowish and gray tints, 1–2 mm thick. Consistency brittle cardboard-like when dry, easily cut and disintegrating into small pieces. Pores rather regular, rounded angular, 6–8 per

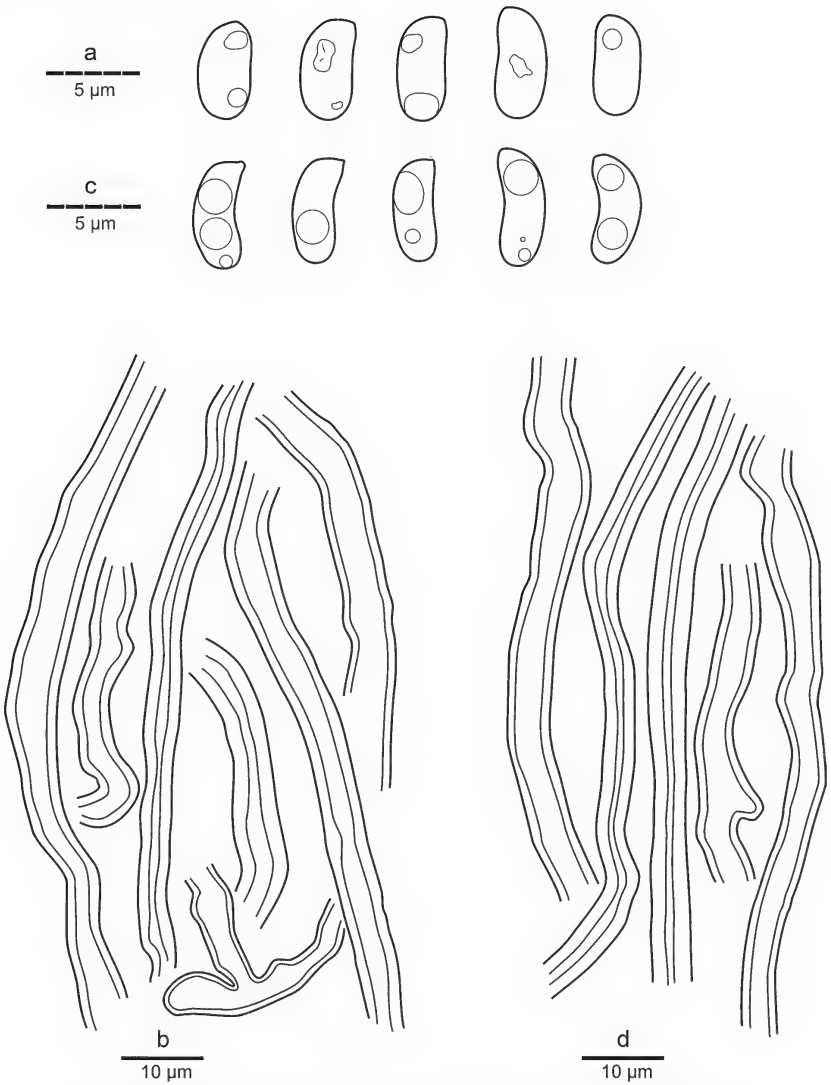

Plate 1. *Cinereomyces dilutabilis* (holotype): a) spores, b) tramal skeletal hyphae. *Cinereomyces lindbladii* (HK 19911 and OM 8647): c) spores, d) tramal skeletal hyphae.

mm, walls of moderate thickness. Subiculum a thin line, concolorous or lighter than tubes.

Hyphal system dimitic throughout, dominated by interwoven skeletal hyphae, tissue rather loose. Generative hyphae thin-walled, 2–3.3 µm in diameter, clamps always present. Subicular skeletal hyphae interwoven, winding,

variable in width, (3.7–)4–5.2(–6.4) µm in diameter, with a distinct lumen ranging between 1/4 to 4/5 of hyphal width, CB–, weakly amyloid in masses, quickly dissolving in KOH. Tramal skeletal hyphae similar as in subiculum, (2.6–)3.7–5(–6.7) µm in diameter. Unusual, narrow (0.6–1.4 µm) arboriform hyphae present in parts of subiculum. Basidia and basidioles thin-walled, short clavate to barrel-shaped, about 10–15×5–7 µm. Basidia with four sterigmata. Cystidioles subulate with a short nape-like neck, not much differentiated.

Basidiospores broadly cylindrical to ellipsoid, curved, thin-walled, smooth, 4.8–5.5(–5.6)×(2.3–)2.4–2.8(–2.9) µm, L = 5.16 µm, W = 2.62 µm, Q' = 1.8–2.2(–2.3), Q = 1.97, n = 31 (holotype). Apiculus small, usually invisible.

Distribution. Described from South Brazil, reported from Costa Rica (Carranza Velázquez & Ruiz-Boyer 2005) and Honduras (Kout & Vlasák 2010). Based on the spore and pore sizes given by Kout & Vlasák (2010), the Honduras find appears to be either *C. lindbladii* or something else.

Specimens examined: ***Cinereomyces dilutabilis***. **BRAZIL. Santa Catarina**, Florianópolis, Campus UFSC, Trindade, 24.I.1989, Loguercio-Leite & Furlani 365 (FLOR 10693, holotype); Florianópolis, Costeira do Ribeirão, Sítio do Jambo, 9.V.1995, Foresti, Gerber & Loguercio-Leite s.n. (FLOR 11169).

Cinereomyces lindbladii. **FINLAND. Varsinais-Suomi**. Raasepori, Tenhola, on *Pinus sylvestris*, 13.X.2000, Kotiranta 16851 & Saarenoksa (H); **Uusimaa**. Vihti, Poikkipuoliainen E, on *Picea abies*, 28.IV.2004, Miettinen 8458 (H, FLOR); Inkoo, Sommarn, on *Pinus sylvestris*, 24.V.2003, Kotiranta 19911 (H); Helsinki, Viikki, on *Salix caprea*, 17.VI.2008, Miettinen 12696 (H).

Remarks. Loguercio-Leite & Wright (1998) provided microscopic drawings of the type. I did not find good-quality hymenium in the holotype, and hymenial cells in FLOR 11169 are also slightly bloated and collapsed.

Cinereomyces dilutabilis shares similar hyphal structure with *C. lindbladii*. Skeletals are amyloid and acyanophilous, have an easily visible, often wide lumen, and are winding and somewhat irregular with occasional branching (Pl. 1). Air is sometimes trapped inside hyphal lumina in microscopic slides. The hyphae of *C. dilutabilis* appear even more irregular and winding than those of *C. lindbladii*. The skeletals dissolve in KOH in both species. Also spores of both species share the similar curved cylindrical shape, are thin-walled, and have an almost invisible apiculus (Pl. 1). One or a few shiny bodies are typically present in the spores.

Cinereomyces dilutabilis differs from *C. lindbladii* by its more fragile and small-pored basidiomes (pores per mm 6–7 vs. 3–4), and wider spores (width commonly >2.5 µm vs. 1.8–2.4 µm).

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Uncobasidium roseocremeum sp. nov. and other corticioid basidiomycetes from the Patagonian Andes of Argentina

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Abstract—Eighteen corticioid species are reported as new from the Patagonian Andes of Argentina, most of them new records for South America or for the southern hemisphere. Comments are included for all species with illustrations provided for some. *Uncobasidium roseocremeum* is described as new and a key to the accepted *Uncobasidium* species is included.

Key words—*Cerocorticium*, *Corticiaceae*, *Globulicium*, *Globuliciopsis*, wood-inhabiting fungi

Introduction

During an extensive investigation of the diversity of *Corticiaceae* s.l. in the Patagonian Andes forests some years ago, a total of 168 species were reported for the area (see Greslebin & Rajchenberg 2003 for a compendium). Study of corticioid fungi in southern Argentina and Chile was recently continued (Gorjón et al. 2011a,b,c, 2012; Gorjón & Hallenberg 2012). As a result of herbarium revisions and collections of new underexplored areas and substrata, we report here 19 noteworthy species, one of them new to science. All species represent new records for Patagonia, while some that are poorly known or show a restricted distribution are reported here for the first time for South America or the southern hemisphere.

Material & methods

For light microscopic studies, samples were mounted in 3% potassium hydroxide (KOH), Melzer's reagent (IKI), and 0.1% cotton blue in 60% lactic acid to determine cyanophily of basidiospores. Line drawings were made with a camera lucida attachment. All specimens here reported are deposited in the herbarium of the "Centro de Investigación y Extensión Forestal Andino Patagónico" (CIEFAP, Esquel, Argentina). Types of *Uncobasidium roseocremeum* are deposited in BAFC, SALA, and CIEFAP.

Recorded species

Amaurodon viridis (Alb. & Schwein.) J. Schröt., Pilze Schles. 1: 461, 1888.

According to Hjortstam & Ryvarden (2007) *Amaurodon viridis* has a pantropical distribution. The Patagonian specimen fits the morphological species concept well.

Specimen examined—**ARGENTINA. Neuquén**: Lanín National Park, around Lolog lake, on dead wood of *Nothofagus obliqua* (*Nothofagaceae*), 19.V.2010, coll. S.P. Gorjón 2847.

Description & illustration—Kõljalg (1996).

Botryobasidium isabellinum (Fr.) D.P. Rogers, Univ. Iowa Stud. Nat. Hist. 17: 11, 1935.

A cosmopolitan and widely distributed species. We have no knowledge of previous records from Argentina. In South America it is present in Brazil, Colombia, Ecuador, Guyana, Venezuela (Hjortstam & Ryvarden 2007), and Uruguay (Martínez & Nakasone 2010).

Specimens examined—**ARGENTINA. Chubut**: Los Alerces National Park, around Rivadavia lake, on dead wood of *Nothofagus dombeyi*, 30.III.2011, coll. S.P. Gorjón 3065, 3066; Lago Puelo National Park, Los Hitos, on dead wood of *N. dombeyi*, 14.V.2010, coll. S.P. Gorjón 2785. **Neuquén**: Nahuel Huapi National Park, Victoria Island, on dead wood *N. dombeyi*, 10.XII.2009, coll. S.P. Gorjón 2561.

Description & illustration—G. Langer (1994).

Cristinia eichleri (Bres.) Nakasone, Cryptog., Mycol. 29: 256, 2008.

This species differs from other *Cristinia* Parmasto species mainly by its odontioid to hydnoid hymenophore. It has been treated under several names in the literature [vid. *Cristinia gallica* (Pilát) Jülich, *Cristinia mucida* (Bourdot & Galzin) J. Erikss. & Ryvarden]. *Cristinia eichleri* was previously not known from the southern hemisphere (cf. Hjortstam & Ryvarden 2007).

Specimen examined—**ARGENTINA. Chubut**: Lago Puelo National Park, Los Calabozos, on dead wood of *Austrocedrus chilensis* (*Cupressaceae*), 4.V.1998, coll. A. Greslebin 1616.

Description—Nakasone (2008).

Dentipellis aff. ***parmastoi*** (Nikol.) Stalpers, Stud. Mycol. 40: 37, 1996.

The examined specimen is morphologically similar to *Dentipellis parmastoi*, but differs in slightly narrower basidiospores, 4–5(–6) × 2–2.2(–2.5) µm [(4–) 4.5–5.5(–6) × (2.5–)3–4 µm in *D. parmastoi*]. Stalpers (1996) did not confirm the presence of cylindrical septate cystidia reported by Nikolajeva (1967), but these structures are easily distinguished in the Argentinean specimens. *Dentipellis parmastoi* is known only from the type locality in Russia, and in the absence of more diagnostic characters we prefer to keep the studied specimens as a morphological 'species affinis.' Hjortstam & Ryvarden (2007) report two

more *Dentipellis* species from South America: *D. dissita* (Berk. & Cooke) Maas Geest., and *D. leptodon* (Mont.) Maas Geest., both with broader basidiospores.

Specimens examined—**ARGENTINA. Chubut**: Los Alerces National Park, southern arm of Menéndez lake, on bark of dead *Fitzroya cupressoides* (*Cupressaceae*), 8.V.1998, coll. A. Greslebin 1628, (previously published as *Hypochniciellum oblongisporum*, see Greslebin & Rajchenberg 1999). Los Alerces National Park, Alerzal milenario, on bark of dead *F. cupressoides*, 3.V.2010, coll. M. Rajchenberg 12294.

Gloeocystidiellum clavuligerum (Höhn. & Litsch.) Nakasone, Mycotaxon 14: 320, 1982.

As noted by Nakasone (1982), *G. clavuligerum* is close to *G. porosum* (Berk. & M.A. Curtis) Donk, differing in the more ellipsoid basidiospores and gloeocystidia with apical constrictions. The Patagonian specimens agree with *G. clavuligerum* also in basidiospore size and shape. The species is widely distributed in North America and Europe, but we are unaware of any previous records from South America. *Gloeocystidiellum porosum* is more common in Patagonia and has been recorded growing on several substrates (Greslebin & Rajchenberg 2003).

Specimen examined—**ARGENTINA. Chubut**: Los Alerces National Park, cerro Dedal, on dead wood of *Nothofagus pumilio*, 9.V.1997, coll. A. Greslebin 1041.

Hyphodermella corrugata (Fr.) J. Erikss. & Ryvarden, Cortic. N. Eur. 4: 579, 1976.

A common and widely distributed species, previously known in South America from Brazil, Colombia, and Paraguay. Hjortstam & Ryvarden (2007) regarded its presence in Argentina as doubtful, but we now confirm its presence in Patagonia.

Specimen examined—**ARGENTINA. Río Negro**: Foyel, on dead wood of *Nothofagus antarctica*, 29.I.2010, coll. S.P. Gorjón 2595.

Descriptions & illustrations—Eriksson & Ryvarden (1976); Duhem (2009).

Hyphodontia breviseta (P. Karst.) J. Erikss., Symb. Bot. Upsal. 16(1): 104, 1958.

Previously reported from Colombia and northern Argentina in South America, the distribution now extends to Patagonia. It is widely distributed in the northern hemisphere.

Specimen examined—**ARGENTINA. Chubut**: Lago Puelo National Park, Melo river, on unidentified wood, 4.V.1998, coll. A. Greslebin 1590.

Description & illustration—E. Langer (1994).

Jaapia ochroleuca (Bres.) Nannf. & J. Erikss., Svensk Bot. Tidskr. 47: 184, 1953.

Plate 1

This species is recognized by the tubular thick-walled cystidia and thick-walled dextrinoid and cyanophilous basidiospores. Also known from several European countries and Kenya.

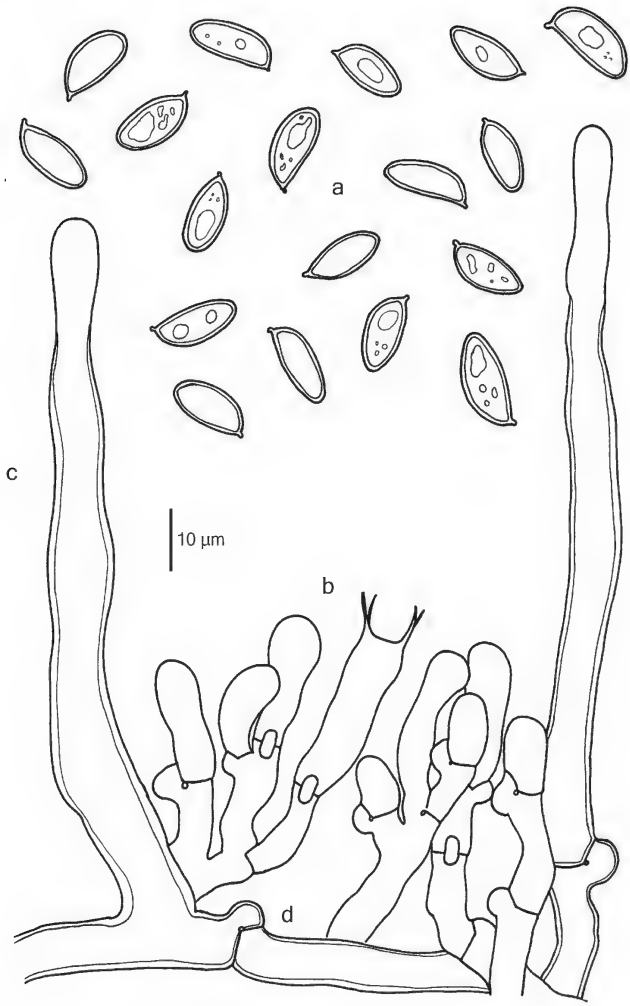

Plate 1. *Jaapia ochroleuca* (S.P. Gorjón 2812).
Hymenial elements: a) basidiospores; b) basidia; c) cystidia; d) hyphae.

Specimen examined—**ARGENTINA. Neuquén:** 7 lakes route, between Espejo and Correntoso lakes, on dead wood of *Nothofagus dombeyi*, 17.V.2010, coll. S.P. Gorjón 2812.

Description & illustration—Eriksson & Ryvarden (1976).

Phlebia acanthocystis Gilb. & Nakasone, in Nakasone & Gilbertson, Folia Cryptog. Estonica 33: 85, 1998. Plate 2

Characterized by its ventricose rostrate leptocystidia. Argentinean collections have slightly larger ellipsoid to subcylindrical basidiospores (5–6 ×

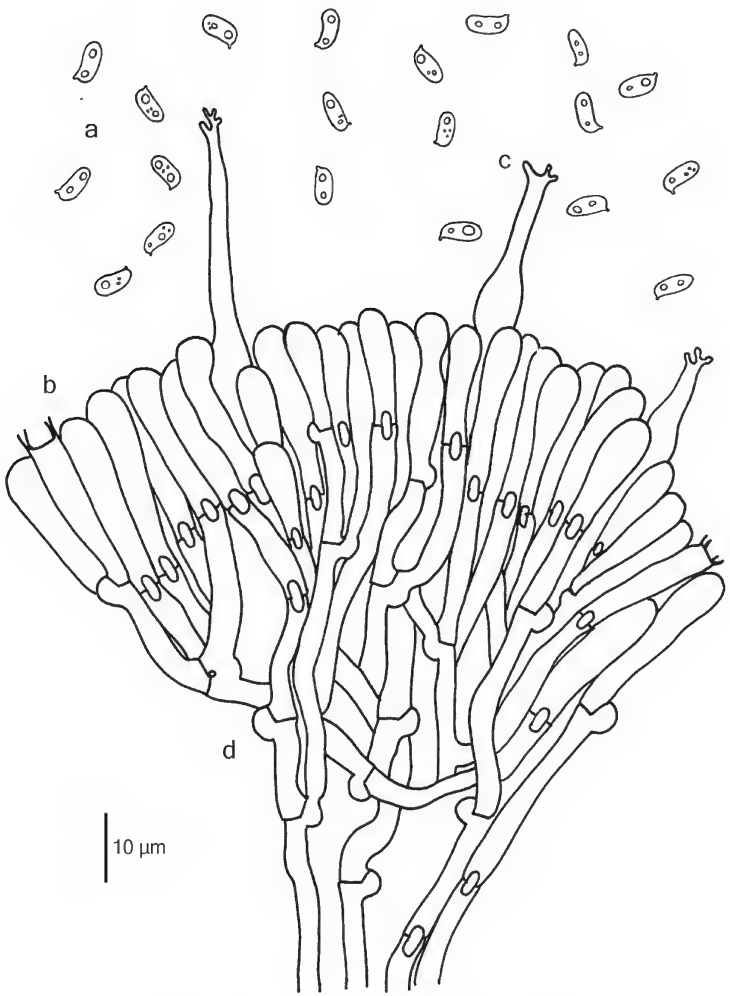

Plate 2. *Phlebia acanthocystis* (S.P. Gorjón 3253).
Hymenial elements: a) basidiospores; b) basidia; c) cystidia; d) hyphae.

2–2.5 µm), than those reported by Nakasone & Gilbertson (1998) [3–4.5(–5) × (1.8–)2–2.5 µm], but other features agree well with the species concept. Duhem (2008) reported some specimens from continental France and La Réunion, with basidiospores measuring 3–4(–5) × 2–2.4 µm. Also known from the Hawaiian Islands, Japan, Réunion, and France.

Specimens examined—**ARGENTINA. Chubut**: Los Alerces National Park, in front of Port Chucao, on dead wood of *Nothofagus dombeyi*, 25.IV.2009, coll. A. Greslebin s/n.

NEUQUÉN: Nahuel Huapi National Park, Puerto Blest, on bark of dead branches of *N. dombeyi*, 15.IV.2011, coll. S.P. Gorjón 3253.

Phlebia aurea (Fr.) Nakasone, Sydowia 49: 55, 1997. PLATE 3

Among the hydnoid *Phlebia* Fr. species, *P. aurea* is diagnosed by the absence of hymenial cystidial elements and small basidiospores. Widely distributed through the temperate northern hemisphere, also known from Canary Islands, Kenya, Tanzania, and India. Also reported from southern Brazil by Gerlach & Loguercio-Leite (2011, sub *Mycoacia* Donk).

SPECIMEN EXAMINED—**ARGENTINA**. **NEUQUÉN**: San Martín de los Andes, around Lolog lake, on dead wood of *Nothofagus obliqua*, 19.V.2010, coll. S.P. Gorjón 2850.

DESCRIPTION & ILLUSTRATION—Nakasone (1997).

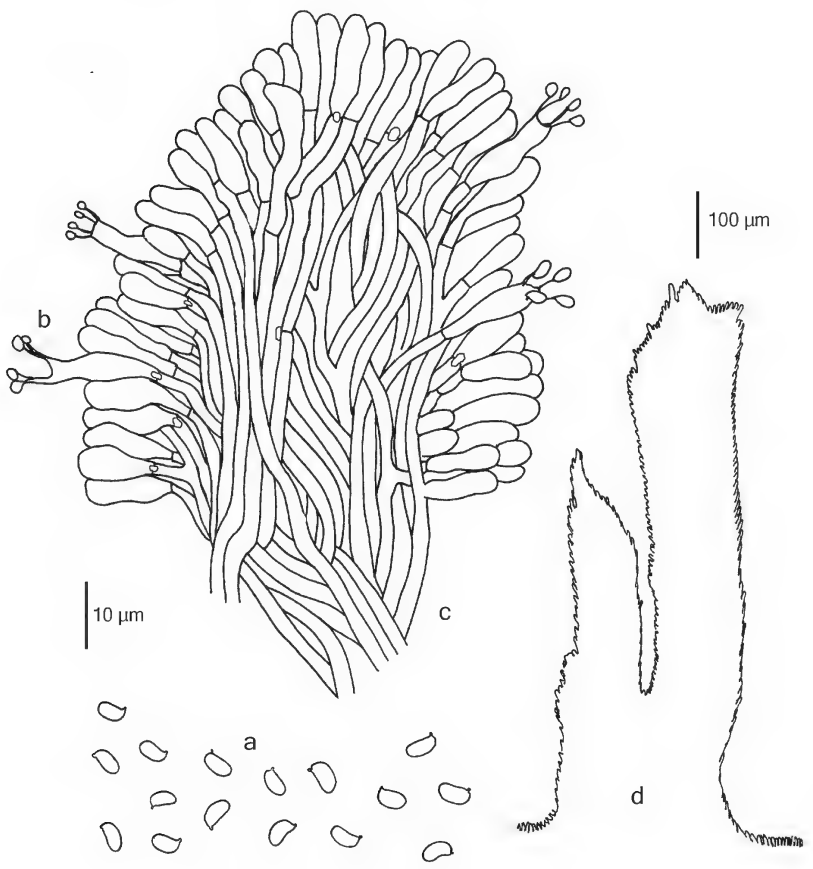

PLATE 3. *Phlebia aurea* (S.P. Gorjón 2850).
Hymenial elements: a) basidiospores; b) basidia; c) hyphae; d) aculei section.

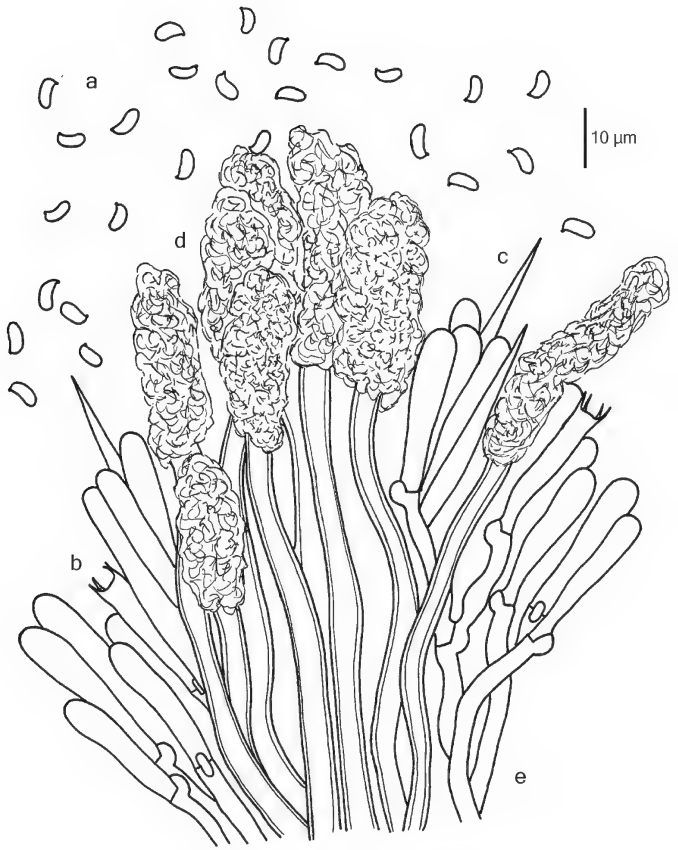

Plate 4. *Phlebia subfascicularis* (A. Greslebin 1644).
Hymenial elements: a) basidiospores; b) basidia; c) leptocystidia; d) encrusted hyphal ends.

Phlebia subfascicularis (Wakef.) Nakasone & Gilb., Folia Cryptog. Estonica 33: 87, 1998. Plate 4

A very characteristic species easily to recognize macroscopically by the dark brown basidiomes with hydnoid hymenophore. Microscopically it is distinguished by the presence of subulate leptocystidia and encrusted skeletoid hyphal ends, either single or (usually) forming encrusted fascicles. Also known from Australia, Ecuador, Hawaii, and New Zealand.

Specimens examined—**ARGENTINA**. **Chubut**: Los Alerces National Park, southern arm of Menéndez lake, on dead wood of *Nothofagus dombeyi*, 8.V.1998, coll. A. Greslebin 1644, det. K. Nakasone; Bahía rosales stream, on dead wood of *N. dombeyi*, 6.V.2010, coll. S.P. Gorjón 2750. **NEW ZEALAND**. **Westland**: Ahaura, Orwell Creek, on *Nothofagus fusca*, V.1955, leg. J.M. Dingley, det. G.H. Cunningham (PDD 18088).

Phlebiopsis ravenelii (Cooke) Hjortstam, Windahlia 17: 58, 1987.

A cosmopolitan widespread species, also known from northern Argentina, Brazil, and Colombia (Hjortstam & Ryvarden 2007) in the Neotropics.

Specimen examined—**ARGENTINA. Tierra del fuego**: Estancia Moat, on dead wood of *Drimys winteri* (*Winteraceae*), 12.XI.1999, coll. A. Greslebin 2185.

Description & illustration—Bernicchia & Gorjón (2010).

Piloderma byssinum (P. Karst.) Jülich, Ber. Deutsch. Bot. Ges. 81: 418, 1969. Plate 5

Easily identified by the yellowish, subpellicular basidiome with white rhizomorphs, simple-septate generative hyphae, and small thick-walled

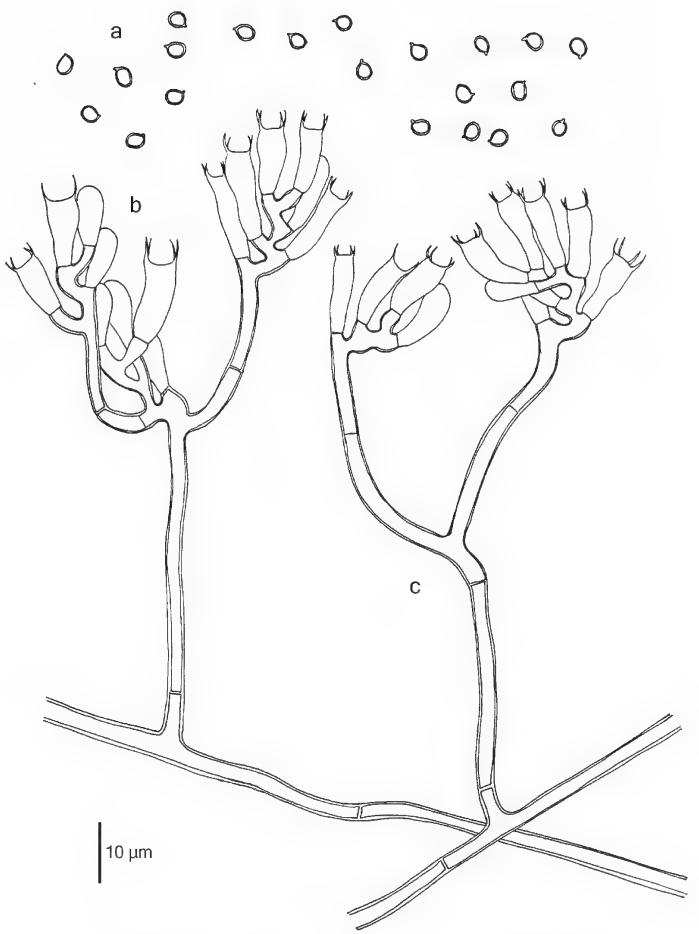

Plate 5. *Piloderma byssinum* (coll. M. Rajchenberg 11711). Hymenial elements: a) basidiospores; b) basidia; c) hyphae.

basidiospores. Known from North America and Europe. New to the southern hemisphere.

Specimens examined—**ARGENTINA. Neuquén:** San Martín de los Andes. Los Lagos, Laguna Rosales, lote 43 CORFONE, on dead wood of *Nothofagus pumilio*, 16.X.1998, coll. M. Rajchenberg 11711, 11714.

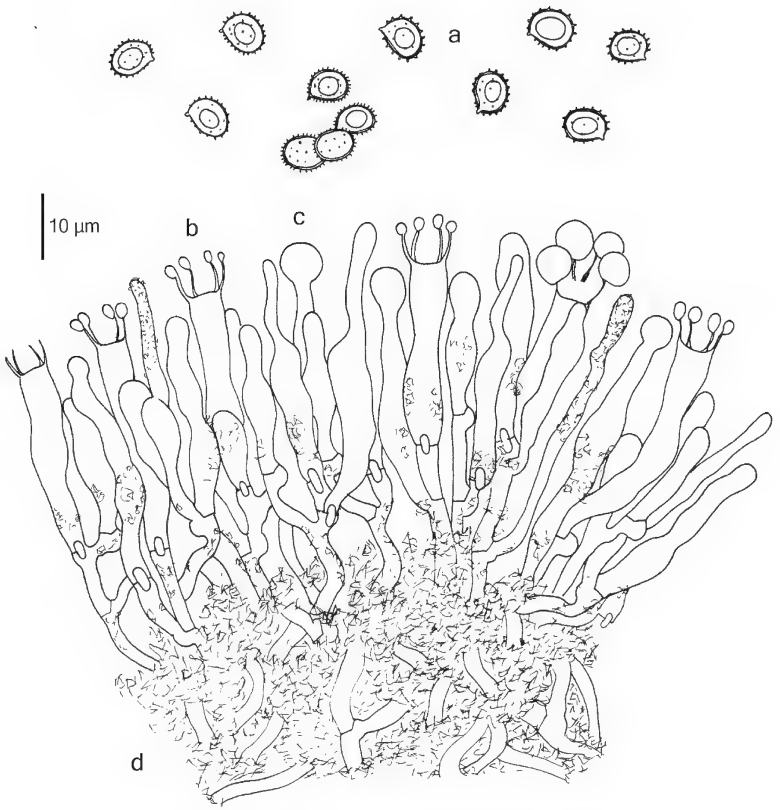

Plate 6. *Rogersella griselineae* (S.P. Gorjón 2701).
Hymenial elements: a) basidiospores; b) basidia; c) cystidioles; d) hyphae.

Rogersella griseliniae (G. Cunn.) Stalpers, New Zealand J. Bot. 23: 305, 1985. Plate 6

Easily identified by the globose and ornamented basidiospores and typically hyphodontoid hyphae. Known from Canary Islands, Colombia, New Zealand, Réunion, Tanzania, Vanuatu, and Venezuela.

Specimens examined—**ARGENTINA. Chubut:** Los Alerces National Park, southern arm of Menéndez lake, on dead wood of *Nothofagus dombeyi*, 3.V.2010, coll. S.P. Gorjón 2701. **Neuquén:** Nahuel Huapi National Park, Puerto Blest, on dead wood of *N. dombeyi*, 30.V.2010, coll. S.P. Gorjón 2957.

Description & illustration—E. Langer (1994).

Sistotrema subtrigonospermum D.P. Rogers, Univ. Iowa Stud. Nat. Hist. 17: 22, 1935.

An inconspicuous species, but apparently widely distributed. In South America previously known from Brazil, Colombia, and Venezuela.

Specimen examined—**ARGENTINA. Chubut**: Los Alerces National Park, Arrayanes sect., on dead wood of *Nothofagus dombeyi*, 30.III.2011, coll. S.P. Gorjón 3054.

Description & illustration—Gorjón & Hallenberg (2008).

Steccherinum ochraceum (Pers.) Gray, Nat. Arr. Brit. Pl. 1: 651, 1821.

Although *S. ochraceum* appears widespread, we do not know previous records from Patagonia.

Specimen examined—**ARGENTINA. Río negro**: Manso inferior river, on unidentified dead wood, 10.IV.2000, coll. A. Greslebin s/n.

Description & illustration—Bernicchia & Gorjón (2010).

Tubulicrinis borealis J. Erikss., Symb. Bot. Upsal. 16(1): 79, 1958.

Widespread in the northern hemisphere and in South America one previous record from Uruguay (as *Tubulicrinis* aff. *borealis*) (cf. Hjortstam & Ryvarden 2007 and Martínez & Nakasone 2010).

Specimen examined—**ARGENTINA. Chubut**: Los Alerces National Park, around Rivadavia lake, on dead wood of *Nothofagus dombeyi*, 30.III.2011, coll. S.P. Gorjón 3081.

Description & illustration—Hjortstam et al. (1988).

Tubulicrinis confusus K.H. Larss. & Hjortstam, in Hjortstam & Larsson, Mycotaxon 26: 437, 1986.

Known from Europe, the Caucasus, Taiwan, and Canada. The specimen from Patagonia fits well the morphological concept.

Specimen examined—**ARGENTINA. Chubut**: Los Alerces National Park, around Rivadavia lake, on dead wood of *Nothofagus dombeyi*, 26.IV.2010, coll. S.P. Gorjón 2641.

Description & illustration—Hjortstam & Larsson (1986); Hjortstam et al. (1988).

Uncobasidium roseocremeum Gorjón, Gresl. & Rajchenb., **sp. nov.** Plates 7–10

MycoBank MB 564887

Ad Uncobasidium calongei *et* U. luteolum *simile sed hyphidia incrustatae presentis, basidiis bisterigmatibus, et basidiosporae globosae grandioribus.*

Type: Argentina, Neuquén: Nahuel Huapi National Park, Puerto Blest, on bark of living *Saxegothaea conspicua* (*Podocarpaceae*), 29.V.2010, coll. S.P. Gorjón 2943 (**Holotype**, BAFC; **isotypes**, SALA, CIEFAP).

Etymology: *roseocremeum*, referring to the basidiome colour.

Basidiomata resupinate, orbicular at first, then confluent, effused, membranous, whitish cream with a pinkish tint, margin white, fibrillose to rhizomorphic, subiculum creamy, felty. hyphal system monomitic, generative hyphae with

Plate 7. *Uncobasidium roseocremeum* (S.P. Gorjón 2824). Basidiome.

clamps, thin- to thick-walled, 3–4 µm wide, smooth or encrusted with large rounded irregular crystals, subicular hyphae yellowish, with abundant crystalline yellowish brown encrustation. CYSTIDIA absent. HYPHIDIA numerous, with an unbranched or usually branched apex, projecting above the basidial layer, some encrusted with large round crystals, in young basidiomes densely encrusted and forming a dense palisade above the immature basidia. BASIDIA narrowly clavate, sinuous, with a long stalked base, usually with one or two basal or medial lateral protuberances, thin-walled, 60–100 × 6–8 µm, guttulate, with two long sterigmata, and a basal clamp. Basidiospores globose, 11–14 µm in diam, smooth, thin or with slightly thickened walls, hyaline, guttulate, IKI–.

In Patagonia this is a quite frequent species growing exclusively on bark of *Saxegothaea conspicua* Lindl. (*Podocarpaceae*). The new species is macroscopically easily to identify by the orbicular to effuse basidiomes, whitish to cream coloured with pinkish tints. Microscopically, the large bisterigmate basidia with lateral protuberances, paraphysoid encrusted hyphae, and globose basidiospores are diagnostic.

Uncobasidium roseocremeum differs from *U. luteolum* Hjortstam & Ryvarden (Hjortstam & Ryvarden 1978) and *U. calongei* (Tellería) Hjortstam & Tellería (Tellería 1985, as *Cerocorticium calongei*) by its larger globose basidiospores

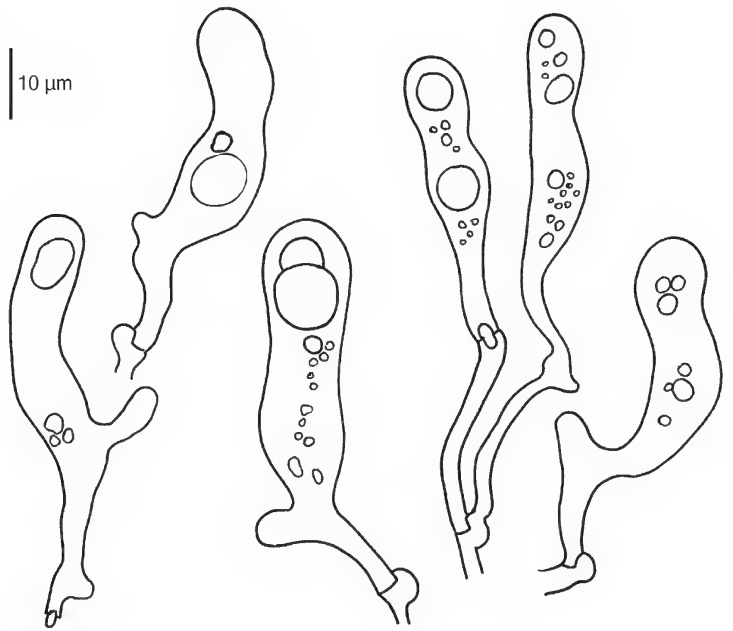

Plate 8. *Uncobasidium roseocremeum* (S.P. Gorjón 2943). Basidia.

and the presence of encrusted hyphidia. Furthermore, the other two *Uncobasidium* species occur exclusively in the northern hemisphere. Gorjón et al. (2011b) erroneously referred to the species as *Globulicium hiemale* (Laurila) Hjortstam. However, *G. hiemale* produces thinner whitish basidiomes with an undifferentiated subiculum, short and wider cylindrical basidia usually lacking or with rare lateral protuberances, and hyphidia differently encrusted with needle-like crystals. *Globuliciopsis fuegiana* Hjortstam & Ryvarden, described from Tierra del Fuego, shares the presence of hyphidia and somewhat globose basidiospores but differs in the ceraceous to subgelatinous basidiomes, tuberculate and ochraceous to reddish hymenial surface, larger basidia lacking lateral protuberances, and slightly larger basidiospores more variable in shape, some oblong to broadly ellipsoid. Moreover, the three species have different host preferences.

Additional specimens examined—***Globuliciopsis fuegiana***. **ARGENTINA. Tierra del fuego:** Dpto. Ushuaia, Paso Garibaldi, on dead wood of *Nothofagus betuloides*, coll. A. Greslebin 1874; El Martial Mont, Ea. Moat, coll. A. Greslebin 1725, M. Rajchenberg 11282.

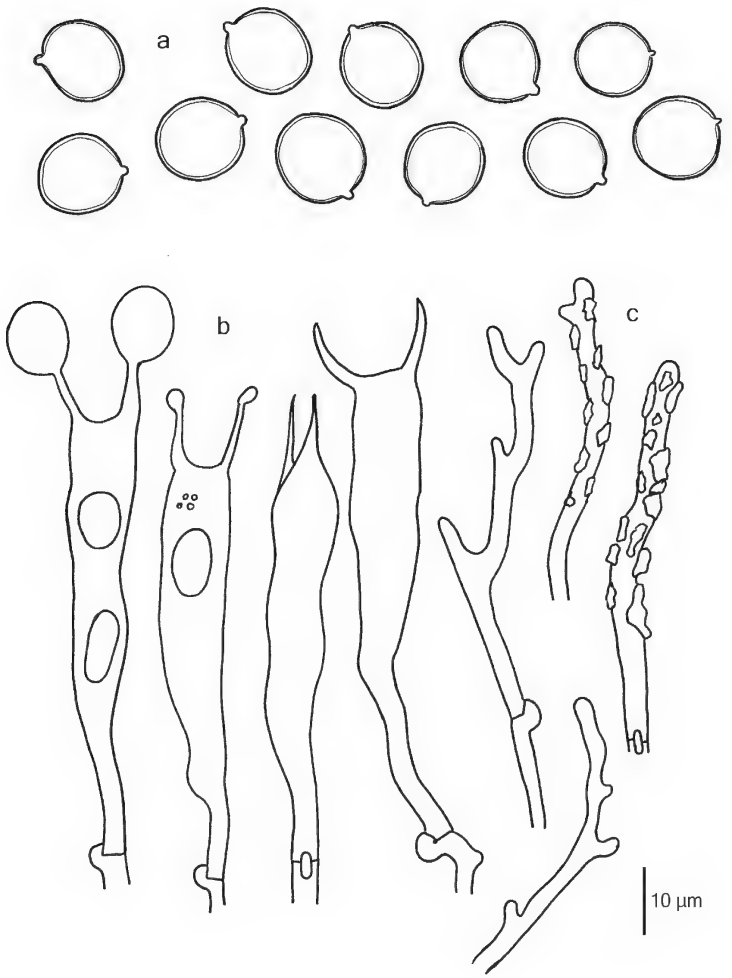

Plate 9. *Uncobasidium roseocremeum* (S.P. Gorjón 2943).
Hymenial elements: a) basidiospores; b) basidia; c) encrusted hyphidia.

Globulicium hiemale. **NORWAY. Hedmark**: Gitvola, on dead wood of *Picea abies* (*Pinaceae*), 22.VIII.1985, coll. A. Bernicchia 3753.

Uncobasidium roseocremeum. **ARGENTINA. Chubut**: Los Alerces National Park, southern arm of Menéndez lake, on bark of living *Saxegothaea conspicua*, 3.V.2010, coll. S.P. Gorjón 2716. **Río negro**: El Bolsón, Camping Los Alerces, on bark of living *S. conspicua*, 13.V.2010, coll. S.P. Gorjón 2762. **Neuquén**: San Martín de los Andes,

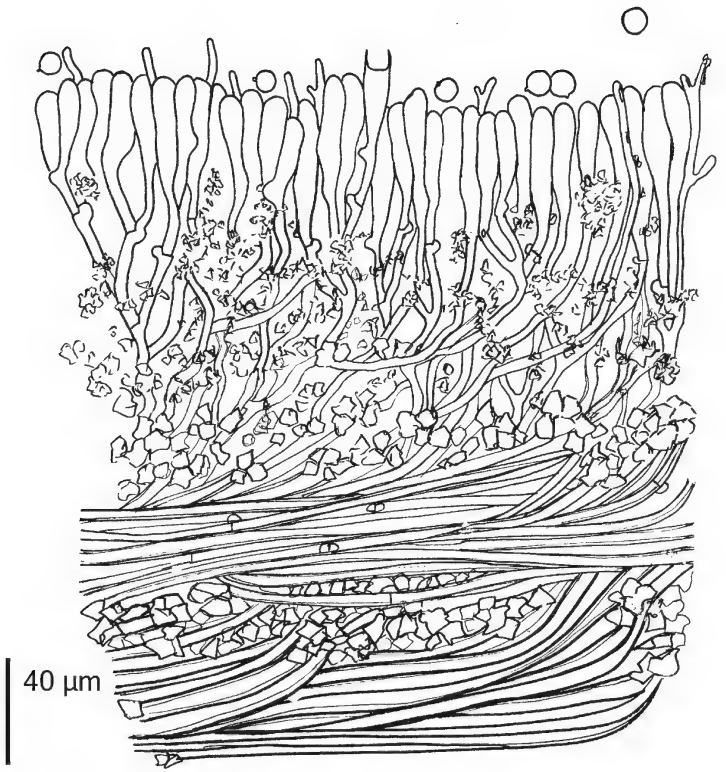

Plate 10. *Uncobasidium roseocremeum* (S.P. Gorjón 2943). Section of the basidiome.

Queni lake, on bark of living *S. conspicua*, coll. S.P. Gorjón 2824, 2827; Nahuel Huapi National Park, Puerto Blest, on bark of living *S. conspicua*, 29.V.2010, coll. S.P. Gorjón 2943. **CHILE. X Region:** Ruta 7, between El Morado bridge and Santa Lucía, on bark of living *S. conspicua,* 06.IV.2011, coll. S.P. Gorjón 3190.

Key to the accepted *Uncobasidium* species

1a. Basidiospores globose, >10 µm in diam, encrusted hyphidia present, basidia with two sterigmata. ..... ***U. roseocremeum***

1b. Basidiospores ellipsoid, ≤10 µm long, hyphidia absent, basidia usually with four sterigmata 2

2a. Basidiospores 6–6.5 × 4–4.5 µm ..... ***U. calongei***

2b. Basidiospores 9 × 6 µm ..... ***U. luteolum***

Acknowledgements

Annarosa Bernicchia (Italy) and Juliano M. Baltazar (Brazil) acted as pre-submission reviewers. Karen K. Nakasone is thanked for her identification help. The Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET, Argentina) supported this research through PIP 80101000. Sergio Pérez Gorjón is a postdoctoral research fellow of the Agencia Española de Cooperación Internacional (MAEC-AECID). Alina G. Greslebin and Mario Rajchenberg are researchers of CONICET.

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Cyathus badius and *C. earlei* reported from the Brazilian Atlantic rainforest

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Abstract — Two rare species of *Cyathus*, *C. earlei* and *C. badius*, were found in remnants of Brazilian Atlantic rainforest located in the city of Natal, Rio Grande do Norte state, Brazil. Both species are new records for South America, and *C. badius* represents the second occurrence for the world. Descriptions, taxonomic remarks, and illustrations of these species are provided.

Key words — *Basidiomycota*, gasteromycetes, neotropics, *Nidulariaceae*, taxonomy

Introduction

For many years the bird's nest fungi (*Cyathus* Haller, *Crucibulum* Tul. & C. Tul., *Mycocalia* J.T. Palmer, *Nidula* V.S. White, and *Nidularia* Fr.) were classified in the *Nidulariaceae* Dumort. (Brodie 1975). This gasteroid group has suffered substantial classification changes since Hibbett et al. (1997) and Moncalvo et al. (2002), who placed the *Nidulariaceae* in the *Agaricales* in an uncertain position among the 'euagarics clade'. However, recent molecular studies indicate that the *Nidulariaceae* occupies a well-defined position in the *Agaricales* where it forms a sister group with the *Cystodermataceae* Locq. (Matheny et al. 2006).

Eleven *Cyathus* species have been reported from Brazil (Trierveiler-Pereira & Baseia 2009a, b, Trierveiler-Pereira et al. 2009), but this seems low compared with the 45 taxa already known (Kirk et al. 2008). Recent estimates of the fungal kingdom (Hawksworth 2001, Blackwell 2011), suggest several unknown species of *Cyathus* still await discovery in tropical forests.

Cyathus species typically occur in forests under decomposing wood and leaves (Brodie 1975). Due to the small basidiome size and limited number of specialists conducting research in neotropical regions, these species are often underestimated or ignored (Baseia & Milanez 2001). The present study aims to broaden the existing knowledge of *Cyathus* species in the Brazilian Atlantic forest.

Materials & methods

Collections were made during the rainy seasons of 2004 to 2009 in the Parque Estadual Dunas do Natal (5°46′S 35°12′W) in the city of Natal, Brazil. Macro- and microscopic characteristics were based on the specialized literature (Calonge 1998, Baseia & Milanez 2001, Brodie 1975, 1984, Brodie & Dennis 1954, Zhou et al. 2004, Zhao et al. 2008). Abbreviations used in spore descriptions follow Zhao et al. (2008): Qm is the mean of the quotient of spore length (represented by L) and width (represented by W) and n is the number of spores observed. Colour codes are according to Kornerup & Wanscher (1978) and vouchers are deposited in the UFRN Herbarium (Thiers 2012).

Taxonomy

Cyathus badius Kobayasi, Bot. Mag., Tokyo 51: 755 (1937). PLATE 1

Peridium infundibuliform, 8–10 mm high, 5–8 mm wide at the mouth, not expanding at the top or tapering abruptly at the base; young fruit bodies with margin curved inwards. Attached to the substrate by a conspicuous and velvety emplacement, 3–5 mm in diameter, brown (6E4). Exoperidium concolourous with the emplacement, shaggy, wooly, smooth to plicate, with 0.3 mm between folds, covered with irregulars tufts of hair; mouth minutely fimbriate, with a 0.2 mm long chocolate-coloured tomentum (6F4). Endoperidium smooth to minutely plicate, with 0.5 mm between folds, light brown to orange (5F1–6D4), slightly shiny. Peridioles 11 per basidioma, light grey to black (1C1–6F3), 2–2.5 × 2–2.2 mm; tunic present, thin, hyaline to yellowish, usually with a distinctly single-layered cortex. Basidiospores 13–19 × 9–11 μm (Qm = 1.66; L = 17.1 μm; W = 10.3 μm; n = 30), smooth, hyaline, ovoid to elliptical, occasionally subglobose, thick-walled (1.9–3.2 μm).

SUBSTRATE: Growing on decaying wood.

SPECIMENS EXAMINED: **BRAZIL. RIO GRANDE DO NORTE: NATAL,** Parque Estadual Dunas de Natal, 18.VI.2009, leg. M.M.B. Barbosa & R.H.S.F. Cruz (UFRN 1318); 03.VI.2008, leg. E.P. Fazolino & I.G. Baseia (UFRN 562).

DISTRIBUTION: Japan (Kobayasi 1937), Brazil.

TAXONOMIC REMARKS: *Cyathus badius* forms part of the *olla* group in the traditional classification by Brodie (1975) and the "pallidum" group in the molecular classification by Zhao et al. (2007). According to Brodie (1975), it is morphologically similar to *C. africanus* H.J. Brodie and *C. earlei*. In relation to *C. africanus*, differences are notable in the lack of conical patterns in tomentum

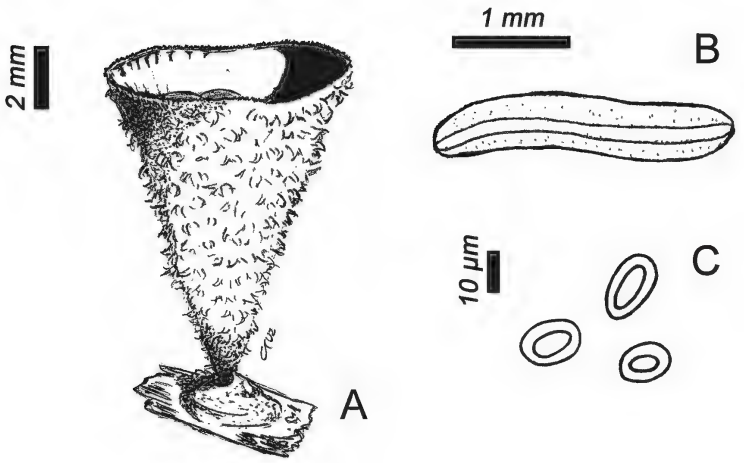

Plate 1. *Cyathus badius*.
A. Basidioma. B. Peridiole with distinct single cortex. C. Basidiospores.

tufts. The spores are also significantly larger in *C. badius* compared with *C. africanus* (8.5–12 × 6.5–8.5 µm). When compared with *C. earlei*, there is a marked difference in the cortex region of the peridiole, which is clearly double in *C. earlei* and simple for *C. badius*. Originally described from the Japanese island of Titizima (Kobayasi 1937), this is the first record of this species from South America and the second for the world.

Cyathus earlei Lloyd, Nidulariaceae: 26 (1906). Plate 2

Peridium infundibuliform, 7–9 mm high, 5–8 mm wide at the mouth, not expanding at the top or tapering abruptly at the base. Attached to the substrate by a conspicuous emplacement, 2–5.5 mm in diameter, brown (6F5–6F6). Exoperidium concolourous with the emplacement, smooth to plicate, with 0.5 mm between folds; hirsute, covered with irregular tufts of hairs; mouth minutely fimbriate, with 0.2 mm long tomentum. Endoperidium plicate, with 0.5 mm between folds, greyish brown (7F3), contrasting with the exoperidium. Peridioles 12–16 per basidioma (average of 14), grey (3E1), 2–2.5 × 1.5–2 mm; tunic present, thin, hyaline, silvery-white with double layered cortex. Basidiospores 15.2–17.8 × 9.5–11.4 µm (Qm = 1.55; L = 16.3 µm; W = 10.5 µm; n = 30), smooth, hyaline, ovoid to elliptical, thick-walled (1.9–2.5 µm).

Substrate: Growing on decaying seeds.

Specimens examined: **BRAZIL. Rio Grande do Norte: Natal**, Parque Estadual Dunas de Natal. 10.VII.2004, leg. I.G. Baseia, P.P.T. Lacerda (UFRN 1, 2).

Distribution: Cuba, Hawaii (Lloyd 1906), Puerto Rico, Mexico, West Indies (Brodie & Dennis 1954), Brazil.

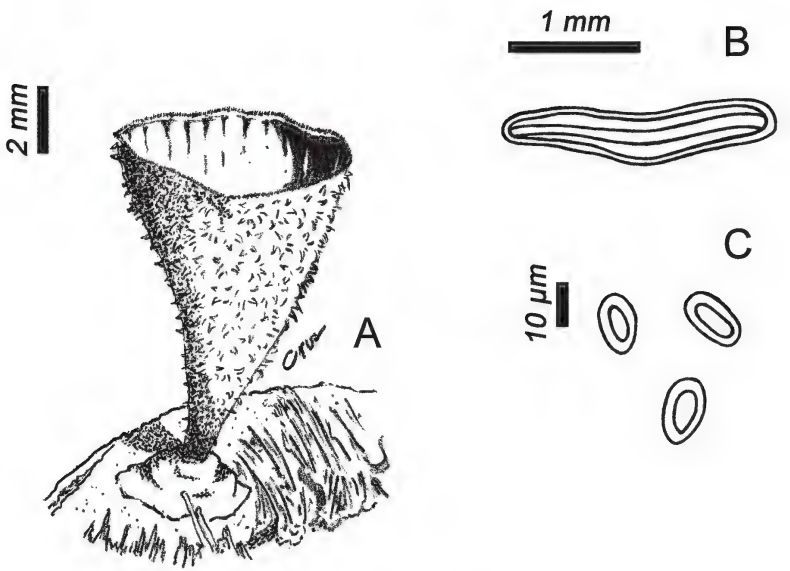

Plate 2. *Cyathus earlei*.
A. Basidioma. B. Peridiole with double layered cortex. C. Basidiospores.

Taxonomic remarks: *Cyathus earlei* belongs to the *olla* group according to the traditional classification by Brodie (1975) and the "pallidum" group based on molecular data from Zhao et al. (2007). Macroscopically it can be confused with *C. olla* (Batsch) Pers. Distinctive differences in *C. earlei*, however, are the double-layered cortex (cf. the simple cortex in *C. olla*), the smaller basidiomata (cf. 10–15 mm in *C. olla*; Brodie 1975), the larger basidiospores (cf. 10–14 × 6–8 µm in *C. olla*; Brodie 1975), as well as smaller peridioles (cf. up to 3.5 mm in *C. olla*; Brodie 1975). In contrast to other *Cyathus* species that are normally found on decaying wood or dung, this species occurred on decaying seeds of native plants. This is the first record of *C. earlei* from South America.

Acknowledgments

The authors would like to thank the CNPq and CAPES for providing financial support in the form of PhD and MSc. scholarships. Our special thanks to Prof. F. Wartchow and Prof. J.C. Coetzee for their revisions.

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MYCOTAXON

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First report of *Stemphylium lycopersici* from Far East Russia: a new record and new host

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Abstract — Recovery of *Stemphylium lycopersici* in Russia is documented for the first time. The pathogenic fungus was isolated from living tomato and chrysanthemum leaves and recovered for the first time from eggplant leaves (*Solanum melongena*, *Solanaceae*). A brief fungus description and illustration are included. Some phylogenetic, geographic, and ecological information is reviewed.

Key words — distribution, *Lycopersicon esculentum, Stemphylium floridanum*

Introduction

The distribution of many species of the genus *Stemphylium* has not been adequately documented. Notably, the geography and ecology of this genus across Russia have never been thoroughly investigated or reviewed. In an early review of *Stemphylium* in Russia, *S. lycopersici* (Enjoji) W. Yamam. (= *S. floridanum* C.I. Hannon & G.F. Weber), was mentioned only once as a species from the south of the Russian Far East, but with no additional information about host plant or reference (Egorova 1999). In other studies dedicated to diversity of phaeodictyosporic hyphomycetes on vegetables and ornamentals in that same region (mostly surroundings of Vladivostok) (Nelen & Vasilieva 1959; Nelen 1962, 1972; Egorova & Pavlyuk 2006), this species was not described at all. Another similar species described on solanaceous plants, *S. solani* G.F. Weber, has been reported in Russia on tomato stems (Nelen 1968), but the article contained no additional description, and the accompanying figures were of poor quality. Thus, the species could not be clearly defined at that time, but it was certainly not *S. solani* or *S. lycopersici*.

During a study of hyphomycetes infecting leaves of solanaceous crops in 2006–10, approximately 120 samples of leaves (each sample consisted of a set of diseased leaves from one field) were collected in different regions of Russia.

These regions included the European part of the country (North West, Central, East, North Caucasus), south of Western and Eastern Siberia, and the Far East (South and Kamchatka). More than 1000 isolates of phaeodictyosporic hyphomycetes were obtained from those samples and nine isolates were keyed to the genus *Stemphylium*. Four of them were preliminarily identified as *S. lycopersici*. The main objectives of the present work were to positively identify isolates of *S. lycopersici* and to determine substrates and habitats of this species in Russia.

To accomplish this goal, these four isolates of *S.* cf. *lycopersici* from *Solanaceae,* along with a collection of additional Russian *Stemphylium* isolates (n = 51) recovered from other plant families and from different regions of Russia in 2002-2011, were subjected to morphological analysis. All isolates were grown on potato carrot agar (PCA) at 24°C under light/dark cycle (12/12 h) for 8–12 days. All isolates are kept in the Laboratory of Mycology and Phytopathology of the All-Russian Institute of Plant Protection in Saint Petersburg.

Results

As a result of analysis five of 55 isolates examined have been positively identified as *S. lycopersici*: MF-P106011 and MF-P106041 [tomato, *Lycopersicon esculentum* Mill. (= *Solanum lycopersicum* L.), September 2006], MF-P223011 and MF-P223021 (eggplant, *Solanum melongena* L., August 2010), and MF-P310011 (chrysanthemum, *Chrysanthemum* sp., August 2010). All isolates originated from Primorskiy kray (south of the Far East) from the outskirts of Vladivostok (43°14–15′N 132°00–04′E). To our knowledge, this is the first discovery of *S. lycopersici* on eggplant as well as the first conclusively documented discovery of the fungus in Russia.

The *S. lycopersici* colonies were light grey in the central part with wooly colorless aerial mycelium. The diameter of 7-day old colonies on PCA was approximately 50 mm. Sporulation was moderate or abundant. Three of the five isolates (MF-P106011, MF-P223021, and MF-P310011 from tomato, eggplant, and chrysanthemum, respectively) produced on PCA a red brown or yellowish pigment, revealing some variation within the species. Ascomata were absent.

Morphology of all isolates examined corresponded to previously published descriptions (Ellis & Gibson 1975; Nishi et al. 2009). Conidia were oblong conical at the apex, bluntly rounded at the base, with 1–5 transverse eusepta and several transverse, longitudinal or/and oblique distosepta in all transverse divisions (Fig. 1). The total number of transverse septa was 5–8, but distosepta were often weakly seen due to conidia wall ornamentation. Conidia were usually constricted at 3(–4) major transverse septa, pale to mid brown, smooth or minutely verruculose, mostly 50–74 × 16–23 μm, with length/ breadth (l/b) ratio 3:1 or more.

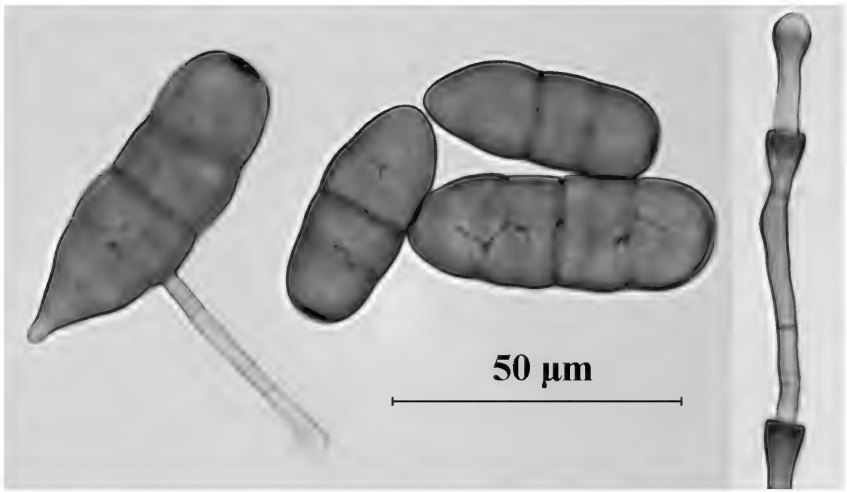

FIG. 1. *Stemphylium lycopersici*: conidia and conidiophores from culture on PCA.

Discussion

In addition to *S. lycopersici,* several other *Stemphylium* species have been found on solanaceous crops including eggplant. In general, these recoveries represent incidental occurrences, except for the recovery of *S. solani*, which has been found perhaps exclusively on solanaceous hosts (Farr et al. 1989; Ellis & Gibson 1975b). Both *S. lycopersici* and *S. solani* are characterized by oblong conidia, pointed at the apex, rounded at the base. However, *S. solani* differs from *S. lycopersici* in a number of features, notably shorter conidia (35–55 × 18–28 µm), smaller l/b ratio (1:2), smaller number of transverse septa (3–6), and conidia that are mostly constricted at the one median septum only.

Stemphylium lycopersici has an unusual host specialization in that only a few plants of two different families (*Solanaceae* and *Asteraceae*) have been described as hosts of this fungus. Among solanaceous plants, the fungus has been revealed on tomato (*Lycopersicon esculentum*) and pepper (*Capsicum annuum* L.) (Saito et al. 1970; Câmara et al. 2002; Inderbitzin et al. 2009). Among asteraceous plants, the fungus has been described from chrysanthemum (*Chrysanthemum morifolium* Ramat.) (Jackson 1961; Tammen 1963; Nishi et al. 2009). *Stemphylium lycopersici* was noted by Ellis & Gibson (1975a) to be a pathogen of some other plants, including *Allium*, *Carthamus*, and *Gladiolus*, but these records have not been supported by other sources.

Molecular phylogenetic study results were concordant with the morphological species concept (Câmara et al. 2002; Inderbitzin et al. 2009). Several gene sequences of isolates from *Chrysanthemum*, *Lycopersicon*, and *Capsicum* have been identical. Interestingly, the closest relatives of *S. lycopersici*

have been obtained from plants of families *Solanaceae*, *Asteraceae*, and *Araceae* (*S. xanthosomatis* B. Huguenin obtained from *Xanthosoma sagittifolium*) (Inderbitzin et al. 2009).

Stemphylium lycopersici has been recorded in many Asian countries, North America, Australia and other places (Kenya, Venezuela, Cuba, Dominican Republic, Indonesia, and Tahiti) (Jackson 1961; Tammen 1963; Ellis & Gibson 1975a; Câmara et al. 2002; Inderbitzin et al. 2009; Nishi et al. 2009). This study has revealed this fungus in Russia as well, but only in the Asian part. Taken together, these data are evidence of the distribution of this fungus in all continents excluding Europe.

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Three new species of *Septobasidium* (*Septobasidiaceae*) from southern and southwestern China

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Abstract —Three new species, *Septobasidium symploci* on *Symplocos* sp. associated with *Aulacaspis* sp., *Septobasidium euonymi* on *Euonymus japonicus* associated with *Aonidiella* sp., and *Septobasidium cotoneastri* on *Cotoneaster rubens* associated with *Aulacaspis* sp., are described. They were collected from Hainan and Yunnan Provinces and Xizang Autonomous Region, China.

Key words —*Pucciniomycetes*, *Septobasidiales*, taxonomy

Southern and southwestern China has a varied and rich mycota. Several mycological investigations dealing with many new species and new Chinese records from these areas have been published recently (Dai et al. 2011, Zhang et al. 2012). An additional three new species of *Septobasidium* are reported as follows:

Septobasidium symploci S.Z. Chen & L. Guo, sp. nov. Figs 1–7

Fungal Name FN 570030

Differs from *Septobasidium thwaitesii* by its smaller basidiomata and basidia.

Type: China, Hainan Province, Bawangling Natural Reserve, alt. 950 m, on *Symplocos* sp. (*Symplocaceae*), associated with *Aulacaspis* sp. (*Diaspididae*), 13.IV.2011, L. Guo 11603, (HMAS 242888, **holotype**).

Etymology: The epithet refers to the substrate plant genus.

Basidiomata on trunks and branches, punctiform, 0.1–2 cm long, 0.1–0.3 cm wide, grey-brown or cinnamon-brown, forming small isolated or confluent patches, irregular growth; margin indeterminate, surface smooth. In section 500–1050 μm thick. Subiculum brownish, 30–50 μm thick. Pillars brown,

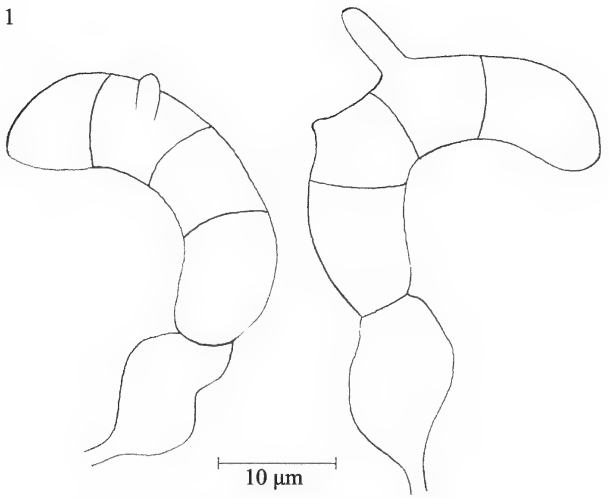


Fig. 1. *Septobasidium symploci* (HMAS 242888, holotype). Probasidia and basidia.

50–80 μm high, 40–50 μm wide. Hyphae often forming 3–4 inconspicuous strata, 400–900 μm high, brown. Hymenium hyaline or brown, 110–135 μm thick. Probasidia subglobose, obovoid or ellipsoidal, 12–18 × 7–14 μm, hyaline or brown. Basidia cylindrical, curved, 4-celled, 32–42 × 8–9 μm, brown, with persisting probasidial cell. Sterigmata conical, 5–8 × 2–3 μm, hyaline. Basidiospores ovoid, 10–20 × 5–6 μm. Haustoria consisting of hyphae.

Comments: *Septobasidium symploci* is similar to *S. thwaitesii* (Berk. & Broome) Pat., but the latter has larger basidiomata, 15–20 cm long, with larger fissions on the surface, slightly larger and wider basidia, 37–46 × 12–13.5 μm, and two conspicuous horizontal layers in the section (Couch 1938).

Septobasidium cotoneastri S.Z. Chen & L. Guo, **sp. nov.** Figs 8–14

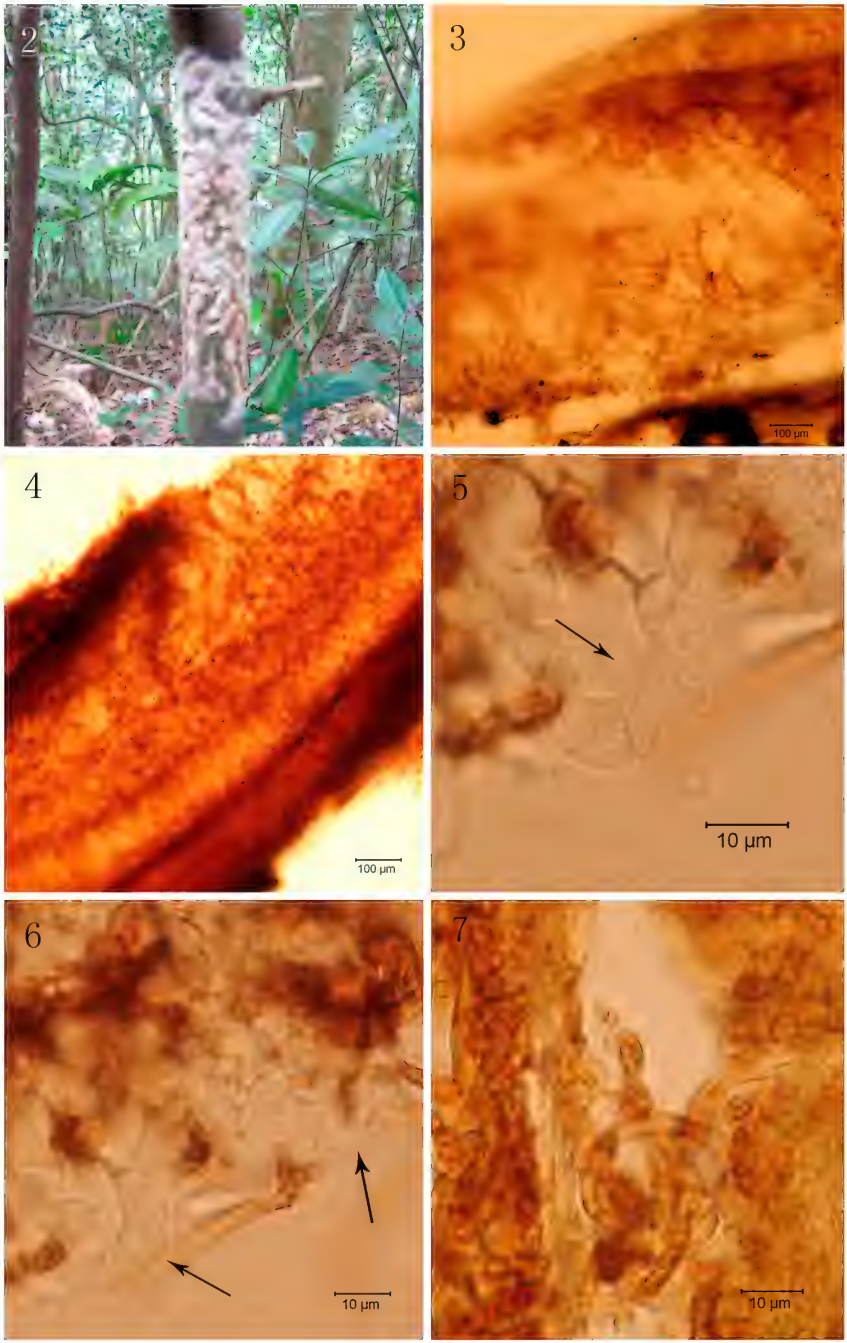
Fungal Name FN 570031

Differs from *Septobasidium patouillardii* by its thicker section and smaller basidia.

Type: China, Xizang, Nyingchi, Gadinggou, alt. 2980 m, on *Cotoneaster rubens* W.W. Sm. (*Rosaceae*), associated with *Aulacaspis* sp., 25.IX.2010, S.H. He XZ11 (HMAS 251318, **holotype**).

Etymology: The epithet refers to the substrate plant genus.

Figs. 2–7 *Septobasidium symploci* (HMAS 242888, holotype). 2. Basidiomata on trunk. 3–4. Sections of basidiomata. 5–6. Probasidia and basidia (arrows). 7. Haustoria.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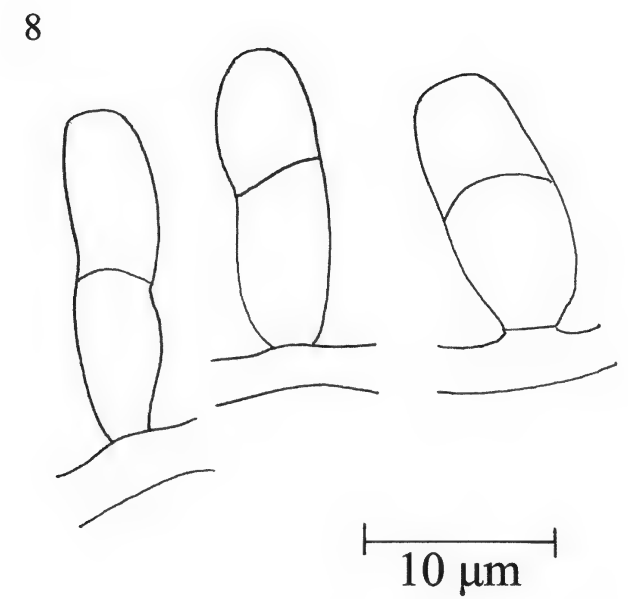
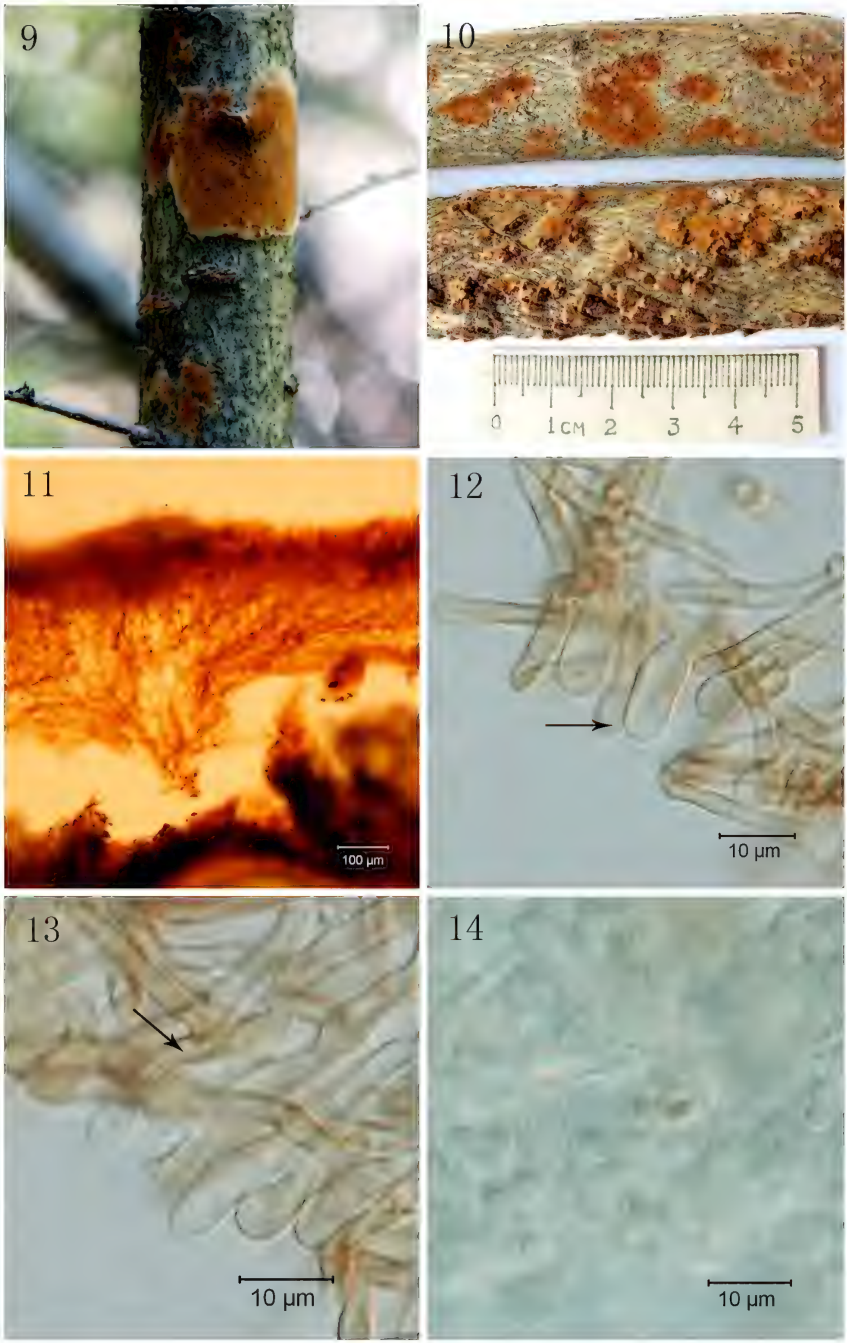


Fig. 8. *Septobasidium cotoneastri* (HMAS 251318, holotype). Basidia.

Basidiomata on branches, 0.2–10 cm long, 0.1–4.5 cm wide, brown or chestnut-brown, forming small isolated or larger patches, irregular growth, sometimes growing along the subiculum, up to 5000 μm high, emerging chestnut-brown hyphal layers; margin determinate, surface smooth, cracked at maturity. In section 600–1750(–5000) μm thick. Subiculum brown, 30–50 μm thick. Pillars brown, 150–200 μm high, 30–70 μm wide. Hyphal layer 200–1100(–4500) μm high, brown. Hymenium hyaline or brown, 80–120 μm thick, with vertical thin-walled, ca. 0.5 μm thick paraphyses. Basidia arising directly from the hyphae without a probasidial cell, clavate, straight, 2-celled, 15–19 × 4–6.5 μm, hyaline or brown; wall 0.5 μm. Basidiospores not seen. Haustoria consisting of regularly coiled hyphae.

Additional specimens examined: **China**, **Xizang**, Nyingchi, Gadinggou, alt. 2980 m, on *Cotoneaster obscurus* Rehder & E.H. Wilson (*Rosaceae*), 25.IX.2010, S.H. He XZ14, (HMAS 251320); on *Sorbus rufopilosa* C.K. Schneid. (*Rosaceae*), 25.IX.2010, S.H. He XZ13, (HMAS 251319); 25.IX.2010, S.H. He XZ19, (HMAS 251328).

Figs. 9–14. *Septobasidium cotoneastri*. 9. Basidiomata on branch (HMAS 251318, holotype). 10. Basidiomata on branches (HMAS 251319, paratype). 11. Section of basidioma (HMAS 251318, holotype). 12–13. Basidia (arrows) (HMAS 251318, holotype). 14. Haustoria (HMAS 251318, holotype).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Comments: *Septobasidium cotoneastri* is similar to *S. patouillardii* Burt, but the latter has a thinner section (300–460 μm high), larger basidia (18–23 × 5.2–5.6 μm) and thick-walled (ca. 3.2 μm thick) paraphyses in the hymenium (Couch 1938).

Septobasidium euonymi S.Z. Chen & L. Guo, **sp. nov.** Figs 15–21

Fungal Name FN 570032

Differs from *Septobasidium patouillardii* by its thinner section and transverse, thin-walled threads in the hymenium.

Type: China, Yunnan Province, Lijiang, Yushuizhai, alt. 2200 m, on *Euonymus japonicus* Thunb. (*Celastraceae*), associated with *Aonidiella* sp. (*Diaspididae*), 25.XI.2011, S.H. He YN01 (HMAS 251324, **holotype**).

Etymology: The epithet refers to the substrate plant genus.

Basidiomata on branches, resupinate, 2–8 cm long, 1.5–4 cm wide, cinnamon-brown, brown or chestnut-brown; margin white, determinate, surface smooth, cracked at maturity. In section 180–320 μm thick. Subiculum brown, 20–40 μm thick. Pillars brown, 60–110 μm high, 20–130(–300) μm wide. Hyphal layer 20–80 μm high, brown. Hymenium hyaline or brown, 50–60 μm thick,

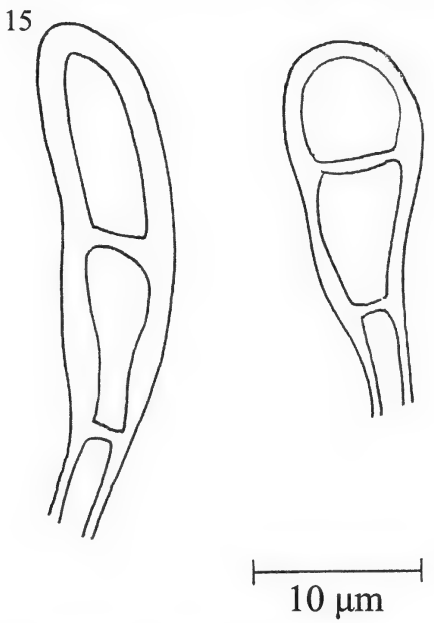
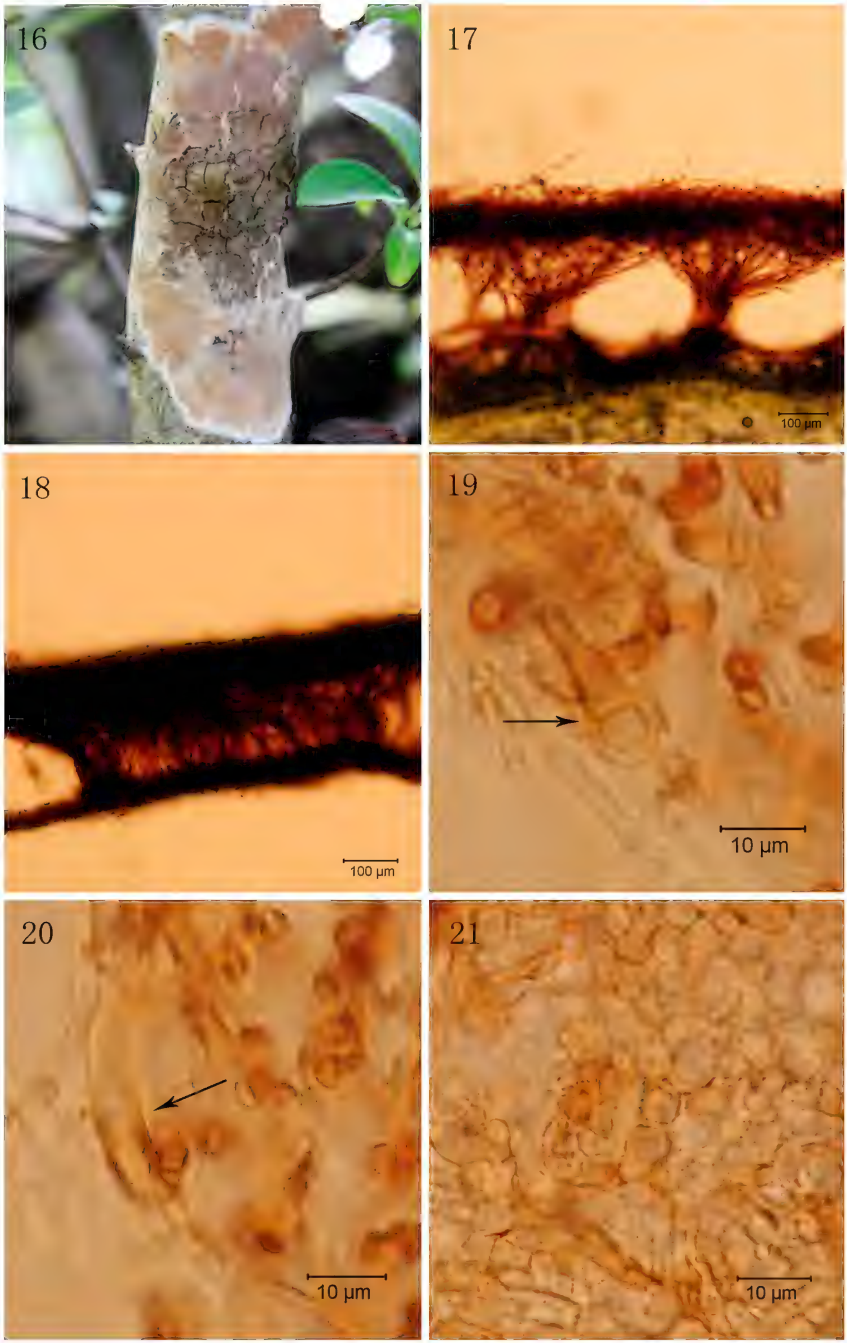


Fig. 15. *Septobasidium euonymi* (HMAS 251324, holotype). Basidia.

Figs. 16–21. *Septobasidium euonymi* (HMAS 251324, holotype). 16. Basidiomata on branch. 17–18. Sections of basidiomata. 19–20. Basidia (arrows). 21. Haustoria.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with transverse, thin-walled threads. Basidia arising directly from the hyphae without a probasidial cell, clavate, straight, 2-celled, 17–25 × 6.5–8 μm, hyaline or brownish; wall ca. 1 μm. Basidiospores not seen. Haustoria consisting of irregularly coiled hyphae and globose cells.

Comments: *Septobasidium euonymi* is similar to *S. patouillardii*, but the latter has a thicker section (300–460 μm high) and vertical, thick-walled (ca. 3.2 μm thick) paraphyses in the hymenium (Couch 1938).

Including the three new species reported in this paper, 49 *Septobasidium* species have now been reported in China (Sawada 1933, Couch 1938, Teng 1963, Tai 1979, Kirschner & Chen 2007, Lu & Guo 2009a,b,c, 2010a,b,c, 2011, Lu et al. 2010, Chen & Guo 2011a,b,c,d, 2012a,b).

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New records of *Lecanora* for Bolivia

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Abstract — *Lecanora cavicola*, *L. laxa*, *L. stenotropa,* and *L. subaurea* are reported as new to South America, and *L. flowersiana* and *L. semipallida* as new to Bolivia. Distributions of the species are discussed and information on their chemistry and diagnostic characters are provided.

Key words — lecanoroid lichens, *Lecanoraceae*, secondary metabolites, Neotropics

Introduction

Although Bolivia is thought to have one of the largest biodiversities worldwide (Ibisch & Mérida 2004), knowledge of its lecanoroid lichens is still underexplored (Nylander 1861, Ryan & Nash 1993, Feuerer et al. 1998, Lumbsch et al. 1996, Guderley 1999, Messuti & Vobis 2003, Feuerer & Sipman 2005, Quilhot et al. 2007). Several of its natural ecosystems are undoubtedly rich in lichen diversity (Flakus & Kukwa 2007, Flakus et al. 2008, 2011, 2012), but these may soon become endangered as in neighbouring countries. Therefore, studies aimed at establishing an inventory of this diversity are fundamental to lichen knowledge and conservation in this part of South America (Flakus 2010).

Only 14 *Lecanora* species were recorded from Bolivia (Rodriguez Flakus et al. 2012), as compared with, for example, 124 known from the comprehensively investigated Greater Sonoran Desert Region in North America (Ryan et al. 2004). The present survey, focused on *Lecanora* and based on part of material collected from various biogeographic regions of Bolivia, has revealed 6 species new to Bolivia, of which 4 are newly reported from South America.

Material & methods

Morphology was studied using standard techniques, with preparations mounted in water or a c. 25% solution of potassium hydroxide (K). Tissue measurements were made in water, and ascospores in K. Granulations were observed in polarized light (pol). The solubility of granules or/and crystals was tested with K and 65% nitric acid (N). Lichen substances were studied by thin-layer chromatography (TLC) using the methods of Culberson & Kristinsson (1970) and Orange et al. (2001). Spot-test reactions with C, K and P were applied to determine the location of secondary metabolites in some specimens.

Voucher specimens are available at KRAM, LPB and herb. Flakus.

Abbreviations used: ANMIN Apolobamba – Área Natural de Manejo Integrado Nacional Apolobamba.

The species

Lecanora cavicola Creveld, Biblioth. Lichenol. 17: 273. 1981.

The species was studied in detail by Poelt & Leuckert (1984) who also provided the first records of fertile individuals of *L. cavicola* from Central Europe. The authors discussed the taxonomic position of this species and concluded it holds an isolated position within the genus. They also chemically proved that the species only produces atranorin and alectorialic acid, although in the original description by Creveld (1981) the species was presented as also containing thamnolic acid (see also Ryan et al. 2004). Flakus (2007) noted the lack of this substance in *L. cavicola* in a west Carpathian population. No thamnolic acid was found in Bolivian material, but traces of the protocetraric complex in addition to atranorin and alectorialic acid (with related compounds) were detected. A revision of the secondary metabolites content based on worldwide sampling is necessary to evaluate the true chemical variation in *L. cavicola*. Detailed descriptions are presented in Poelt & Leuckert (1984) and Ryan et al. (2004).

Lecanora cavicola is widespread but rare in Europe (Creveld 1981, Poelt & Leuckert 1984, Nimis & Martellos 2003, Santesson et al. 2004, Flakus 2007, Edwards et al. 2009); it has also been reported from Asia (central Siberia; Zhurbenko 1996), North America (Nash et al. 1998, Ryan et al. 2004), Greenland (Alstrup et al. 2000), and New Zealand (Galloway 2007). It occurs on hard siliceous rocks in alpine areas. In Bolivia it was found in moist Puna and subnival Andean vegetation. New to South America.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Bautista Saavedra, ANMIN Apolobamba, near Villa Amarca village, 4643 m, 15°16′47″S 69°01′47″W, 2010, Flakus 17347 & Rodriguez (KRAM, LPB); Prov. Franz Tamayo, ANMIN Apolobamba, near Puyo Puyo village, 4888 m, 15°56′55″S 69°07′58″W, 2010, Flakus 17563 & Rodriguez (KRAM, LPB); Pelechuco municipality, Cañuhuma village, near Puntani mountain, 4760 m, 15°01′51″S 69°11′98″W, 2008, Rodriguez 526, 532/2, 541, 549 (LPB); Prov. Murillo, below Potosi near campamento de mineros, on the road La Paz – Valle del

Zongo, 4716 m, 16°17′43″S 68°07′42″W, 2011, Flakus 21851 & Plata (KRAM, LPB); Paso Cumbre near La Paz city, 4405 m, 16°19′6″S 68°02′09″W, 2011, Flakus 22130 & Plata (KRAM, LPB).

Lecanora flowersiana H. Magn., Acta Horti Gothob. 19(2): 38. 1952.

The species, a member of the *L. dispersa* group, is characterized by its sessile apothecia with brown disc and thin, white crenate thalline margin. Anatomically it is distinguished by paraphyses that are simple, thick, agglutinated (coherent in K), and apparently submoniliform and expanded up to 4–5 µm in the uppermost part. The epihymenium (up to 1/3 of the upper hymenium) is deeply pigmented brown or reddish. *Lecanora flowersiana* produces no secondary metabolites. Detailed characteristics are presented in Śliwa (2007a) and de la Rosa et al. (2012).

The monograph of the *L. dispersa* complex in North America (Śliwa 2007a) considers *L. flowersiana* to be a western temperate element confined the central and western regions of the continent. However, later it was recorded in the Canary Islands (van den Boom 2010) and Iran (Valadbeigi & Sipman 2010). De la Rosa et al. (2012) reported *L. flowersiana* for the first time from South America (Argentina), and we now report it from Bolivia. It was found in the semi-desert Inter-Andean Valley in a sunny location on a shrubby rocky slope.

Specimen examined — **BOLIVIA. Dept. Cochabamba**. Prov. Quillacollo, East Cordillera, area of Inkarraya-Sipesipe, dry Inter-Andean Valleys, 3146 m, 17°29′25″S 66°22′09″W, 2004, Wilk 3218 (KRAM, LPB).

Lecanora laxa (Śliwa & Wetmore) Printzen, Bryologist 104: 395. 2001.

The species is characterized by large flexuose and basally constricted apothecia, whitish pruinose discs, broadly ellipsoid ascospores, and production of usnic acid, ± isousnic acid and ± 1–5 terpenoids (incl. zeorin). Detailed descriptions are presented in Śliwa & Wetmore (2000) and Printzen (2001).

Lecanora laxa is most similar to *L. subviridis* de la Rosa & Messuti, recently described from Argentina (de la Rosa et al. 2010). The authors distinguish *L. subviridis* mainly by somewhat smaller apothecia and ascospores, but the characters seem to overlap in both taxa.

When *L. laxa* was described, it was known only from the western part of North America (Śliwa & Wetmore 2000, Printzen 2001), but Martínez & Aragón (2004) reported it from Europe (Spain), and we have now found it in Bolivia. The Bolivian voucher specimen was collected from twigs of a single exposed roadside tree on a S-facing slope covered with montane Yungas forest. New to South America.

Specimen examined — **BOLIVIA. Dept. La Paz.** Prov. Bautista Saavedra, San Juan Piquendo between villages Chullina and Mataro, 3298 m, 15°10′19″S 68°55′05″W, 2006, Wilk 4266 (LPB).

Additional specimen examined — **U.S.A. Wyoming.** Big Horn Co., Near Dayton on U.S. 14 in foothills of Big Horn Mts, on *Pinus ponderosa* on steep S facing hill with scattered pines and juniper, elev. 5300 ft. (1615 m), 1 Aug. 1965, Wetmore 12911 (KRAM; isotype of *L. laxa*).

Lecanora semipallida H. Magn., Lichens from Central Asia 1: 89. 1940.

This distinctive member of the *L. dispersa* group seems to be well circumscribed based on the following phenotypic evidence: sessile apothecia with yellow, yellow-orange to pale brown epruinose to moderately pruinose apothecial discs and thick white entire or crenate margins, epihymenial granules that are soluble in K, and the presence of vinetorin (5-chloro-3-O-methylnorlichexanthone) (Śliwa 2007a,b). Detailed characteristics are presented in Śliwa (2007a) and de la Rosa et al. (2012).

Lecanora semipallida was shown to be a monophyletic species, but this is only partly supported on the basis of phylogenetic inferences from the ITS region (Śliwa et al. 2012). Part of the South American material reminiscent of *L. semipallida* showing some morphological, chemical, and genetic differences is not included here and will be treated elsewhere.

The species is new to Bolivia but has been noted previously in South America in Argentina (de la Rosa 2012) and Peru (Śliwa et al. 2012). The species is frequent worldwide. It is known from North America, Europe, Asia, Australia, and New Zealand (Śliwa 2007b, 2009a,b, and literature cited therein; Valadbeigi & Sipman 2010). *Lecanora semipallida* occupies predominately calcareous rocks but also occurs on concrete or overgrowing other lichens; it is occasionally corticolous. In Bolivia it was collected on rocks in Puna and subnival Andean vegetation.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Bautista Saavedra, ANMIN Apolobamba, near Taypi Cañuma village, 4506 m, 15°03′20″S 69°09′07″W, 2010, Flakus 17533 & Rodriguez (KRAM, LPB); Prov. Franz Tamayo, ANMIN Apolobamba, near Puyo Puyo village, 4795 m, 15°56′55″S 69°07′58″W, 2010, Flakus 17688 & Rodriguez (KRAM, LPB); Prov. Murillo, near Cumbre pass, 4604 m, 16°21′59″S 68°02′37″W, 2006, Flakus 5811 (KRAM, LPB). **PERU. Dept. Arequipa.** Prov. Caylloma, Valle del Colca valley, near Soccoro village, 3349 m, 15°38′32″S 71°43′22″W, 2006, Flakus 9423 & Cykowska (KRAM).

Lecanora stenotropa Nyl., Flora 55: 251. 1872.

The species can be separated from the superficially similar *L. polytropa* (Ehrh.) Rabenh. by the ascospore shape, which is narrowly ellipsoid in *L. stenotropa* (8–14 × 2.5–4.5 µm; in Bolivian material 9–14 × 3–4 µm) and broadly ellipsoid in *L. polytropa* (10–14 × 5–7 µm) (Edwards et al. 2009, see also Śliwa & Flakus 2011). Both species usually produce fatty acids in addition to usnic acid and zeorin; however, *L. polytropa* contains rangiformic acid, contrasting with isorangiformic acid in *L. stenotropa* (Huneck 1982, Ryan et al. 2004, Edwards

et al. 2009). It should be noted that no fatty acids were detected in the Bolivian *L. stenotropa* population. Detailed descriptions are presented in Ryan et al. (2004) and Edwards et al. (2009).

The species is known from Europe (e.g. Crespo et al. 2003, Nimis & Martellos 2003, Santesson et al. 2004, Flakus 2007, Edwards et al. 2009), North America (LaGreca & Lumbsch 2001), and New Zealand (Galloway 2007). It is probably much more widespread but overlooked due to its morphological similarity to *L. polytropa*. The two species also share the same substrate preference (hard siliceous rocks); however, *L. stenotropa* has to date been recorded only from alpine habitats. In Bolivia the species was found in high Andean open vegetation and in an open area near Yungas montane cloud forest. New to South America.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Bautista Saavedra, ANMIN Apolobamba, near Taypi Cañuma village, 4506 m, 15°03′20″S, 69°09′07″W, 2010, Flakus 17517, 17518 & Rodriguez (KRAM, LPB); San Juan Piquendo between villages Chullina and Mataro, 3298 m, 15°10′19″S 68°55′05″W, 2006, Wilk 4179 (KRAM, LPB); **Dept. Santa Cruz.** Prov. Caballero, East Cordillera, Siberia village, 3480 m, 17°49′38″S 64°45′14″W, 2004, Flakus 4813, 4814 (KRAM, LPB, herb. Flakus); Wilk 3105 (KRAM, LPB); Prov. Franz Tamayo, ANMIN Apolobamba, Pelechuco municipality, near Socondori mountain, 4600 m, 15°05′20″S 68°13′9″W, 2007, Rodriguez 238, 245, 250 (LPB); Cañuhuma village, near Puntani mountain, 4760 m, 15°01′51″S 69°11′98″W, 2008, Rodriguez 518, 587 (LPB).

Lecanora subaurea Zahlbr., Cat. Lich. Univers. 5: 547. 1928.

Having yellow-green areolate sorediate usually sterile thalli, *L. subaurea* resembles *L. epanora* (Ach.) Ach. Although superficially similar, the two species differ in morphology, anatomy, chemistry, and habitats (Earland-Bennett 1975). Most frequently they can be distinguished by the soralia, which are mainly marginal in *L. subaurea* and laminal in *L. epanora*. Chemical constituents are also used to determine the species, since *L. subaurea* contains pannarin, rhizocarpic acid, and zeorin (Earland-Bennett 1975, Obermayer 2009), whereas *L. epanora* produces epanorin, rhizocarpic, and zeorin (Earland-Bennett 1975). However, chemical study of the Bolivian *L. subaurea* collection showed the presence of the following secondary metabolites: pannarin, rhizocarpic acid, and traces of epanorin and zeorin. Therefore, only a high concentration of epanorin can be considered as reliable for distinguishing *L. epanora,* although the presence/absence of pannarin remains diagnostic for the two species. The detailed description is presented by Edwards et al. (2009).

In Europe *L. subaurea* is commonly found on rocks rich in heavy metals, especially iron, such as in the mining regions of central Europe, from where it was originally described (Earland-Bennett 1975). It has also been reported as growing on an old leather shoe (Tønsberg 1987). It favours sunny situations. A broad account of the species distribution and ecology is provided by Follmann

(1985). Besides Europe, the species is known from North America (Esslinger & Egan 1995) and Asia (Urbanavichus & Andreev 2010). In Bolivia the species was found in high Andean Puna vegetation. New to South America.

Specimen examined — **BOLIVIA. Dept. La Paz.** Prov. Murillo, near Cumbre pass, 4672 m, 16°20′14″S, 68°02′20″W, 2006, Flakus 5743 (KRAM, LPB).

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Laccariopsis, a new genus for *Hydropus mediterraneus* (*Basidiomycota, Agaricales*)

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Abstract — *Laccariopsis* (*Agaricales*) is a new monotypic genus established for *Hydropus mediterraneus*, an arenicolous species earlier often placed in *Flammulina*, *Oudemansiella*, or *Xerula*. *Laccariopsis* is morphologically close to these genera but distinguished by a unique combination of features: a *Laccaria*-like habit (distant, thick, subdecurrent lamellae), viscid pileus and upper stipe, glabrous stipe with a long pseudorhiza connecting with *Ammophila* and *Juniperus* roots and incorporating plant debris and sand particles, pileipellis consisting of a loose ixohymeniderm with slender pileocystidia, large and thin- to thick-walled spores and basidia, thin- to slightly thick-walled hymenial cystidia and caulocystidia, and monomitic stipe tissue. Phylogenetic analyses based on a combined ITS-LSU sequence dataset place *Laccariopsis* close to *Gloiocephala* and *Rhizomarasmius*.

Key words — *Agaricomycetes, Physalacriaceae,* /gloiocephala clade, phylogeny, taxonomy

Introduction

Hydropus mediterraneus was originally described by Pacioni & Lalli (1985) based on collections from Mediterranean dune ecosystems in Central Italy, Sardinia, and Tunisia. Previous collections were misidentified as *Laccaria maritima* (Theodor.) Singer ex Huhtinen (Dal Savio 1984) due to their laccarioid habit. The generic attribution to *Hydropus* Kühner ex Singer by Pacioni & Lalli (1985) was due mainly to the presence of reddish watery droplets on young lamellae and sarcodimitic tissue in the stipe (Corner 1966, Singer 1982). As this puzzling taxon combines features of several genera within *Physalacriaceae* Corner, the taxonomic position of this species has since been greatly debated and is still far from clear. Contu (1986, 1988) and Robich (1986) retained the taxon in *Hydropus*, but within a brief period, the specific epithet was recombined three times: Horak (1988) transferred it to *Oudemansiella* Speg., mainly because the pileipellis is embedded in a gelatinous matrix, the

stipe is rooting (pseudorhiza), and the basidia and spores are large and thick-walled; Bas & Robich (1988), after demonstrating that stipe tissue in the species is monomitic and clearly not sarcodimitic, treated the species as a *Flammulina* P. Karst., a placement also followed by Bon (1999) and Petersen et al. (2012); and Quadraccia & Lunghini (1990) and Ballero & Contu (1990) transferred it to *Xerula* Maire, where Contu (2000) designated *X. mediterranea* as the type of *Xerula* subg. *Ixoflammula* Contu.

Petersen (2000) and Antonín & Noordeloos (2010) felt that the species might better be placed within *Rhizomarasmius* R.H. Petersen, whose members share with *H. mediterraneus* common features such as a marasmioid habit with a deep rooting stipe, similar pileipellis and stipititrama structure, protruding cystidia, and monomitic trama. But, without molecular evidence, these authors refrained from transferring it to *Rhizomarasmius*.

In their thorough monograph on the *Xerula*/*Oudemansiella* complex (*Physalacriaceae*, Moncalvo et al. 2002, Matheny et al. 2006), Petersen & Hughes (2010) recognized seven genera based on both morphological and molecular data: *Dactylosporina*, *Hymenopellis*, *Mucidula*, *Oudemansiella* s.s., *Paraxerula*, *Ponticulomyces, Protoxerula*, and *Xerula* s.s.; *Hydropus mediterraneus* is not treated in the main taxonomic section (no collection is molecularly studied) but only discussed in the "Type specimen studies" section. Petersen & Hughes (2010) designated as neotype for *H. mediterraneus* a collection by M.M. Moser from Tuscany (no. 94/410, IB), but we have since verified that the holotype collection is housed in AQUI, as correctly indicated in the protologue.

Since *Hydropus mediterraneus* had not been molecularly studied and remained problematic relying only on traditional taxonomical methods, the aim of this paper was to infer the phylogenetic position of the species by using a combined ITS and LSU rDNA analysis.

Materials & methods

Herbarium acronyms follow Thiers (2012) except AP that refers to the personal herbarium of Alessio Pierotti. Author citations follow Index Fungorum (2012). The new genus and new combination are deposited in MycoBank (2012).

DNA extraction, PCR amplification, and DNA sequencing

Genomic DNA was isolated from 1 mg of one herbarium specimen (MCVE 23445), by using the DNeasy Plant Mini Kit (Qiagen, Milan Italy) according to the manufacturer's instructions. Universal primers ITS1F/ITS4 were used for the ITS region amplification (White et al. 1990, Gardes & Bruns 1993) and primers LR0R/LR7 (Vilgalys & Hester 1990; Vilgalys lab 2012) for the LSU rDNA amplification. Amplification reactions were performed in a PE9700 thermal cycler (Perkin-Elmer, Applied Biosystems) following Vizzini et al. (2011). The PCR products were purified with the AMPure XP kit (Beckman) and sequenced by MACROGEN Inc. (Seoul, Republic of Korea). The sequences were submitted to GenBank (2012) and their accession numbers are reported in Figure 1.

Sequence alignment and phylogenetic analysis

The sequences obtained in this study were checked and assembled using Geneious v5.3 (Drummond et al. 2010), and compared to those available in the GenBank database using the blastn algorithm. Based on the blastn results, sequences were selected according to the outcomes of recent phylogenetic studies on *Physalacriaceae* (Binder et al. 2006, Matheny et al. 2006, Petersen & Hughes 2010 and Ronikier & Ronikier 2011). A combined analysis of ITS and LSU sequences was carried out using, when possible, sequences from the same strain or specimen. *Armillaria mellea* (AY789081, AY700194) and *A. tabescens* (AY213590, AF042593) were used as outgroup taxa according to Binder et al. (2006), Matheny et al. (2006), and Ronikier & Ronikier (2011). Alignments were generated using MAFFT (Katoh et al. 2002) with default conditions for gap openings and gap extension penalties. The sequence alignment, its manual adjustment, and the best-fit models estimation follow Vizzini et al. (2011). The GTR+G and GTR+G substitution models was used in the ITS and LSU analysis, respectively. A partitioned matrix was used in all the analyses. Molecular-phylogenetic analyses were performed using the Bayesian Inference (BI) and Maximum Likelihood (ML) approaches. BI using Monte Carlo Markov Chains (MCMC) was carried out with MrBayes 3.1.2 (Huelsenbeck & Ronquist 2001). Four incrementally heated simultaneous MCMC were run over 10.000.000 generations, under model assumption. Trees were sampled every 1.000 generations resulting in an overall sampling of 10.001 trees. The "burn-in" value was evaluated using Tracer 1.5 (Rambaut & Drummond 2007). The first 20% of trees was discarded as "burn-in". For the remaining trees, a majority rule consensus tree showing all compatible partitions was computed to obtain estimates for Bayesian Posterior Probabilities (BPP). ML estimation was performed through RAxML v.7.0.4 (Stamatakis 2006) with 1.000 bootstrap replicates (Felsenstein 1985) using the GTRGAMMA and GTRGAMMA (for ITS and LSU, respectively) algorithm to perform a tree inference and search for a good topology. Support values from bootstrapping runs (MLB) were mapped on the globally best tree using the "-f a" option of RAxML and "-x 12345" as a random seed to invoke the novel rapid bootstrapping algorithm. Only BPP values over 0.60 and MLB over 50% are reported in the resulting tree (Fig. 1).

Results

Molecular results

The combined dataset, which comprises 33 taxa (including 32 from GenBank), is 1883 base pairs long. As both Bayesian and Maximum likelihood analyses produced the same topology, only the Bayesian tree with both BPP and MLB values is shown (Fig. 1).

Both analyses cluster *Hydropus mediterraneus* within a clade (here indicated as the /gloiocephala clade, BPP 0.97, MLB 69%) formed also by four *Gloiocephala* species (including *G. epiphylla* Massee, the type of the genus) and two *Rhizomarasmius* species. This clade is sister to a group here indicated as the /xerula clade (BPP 1, MLB 96%) including *Strobilurus* Singer and *Xerula* s.s.

As traditionally circumscribed, *Gloiocephala* Massee is polyphyletic, as already pointed out by Binder et al. (2006) and Ronikier & Ronikier (2011).

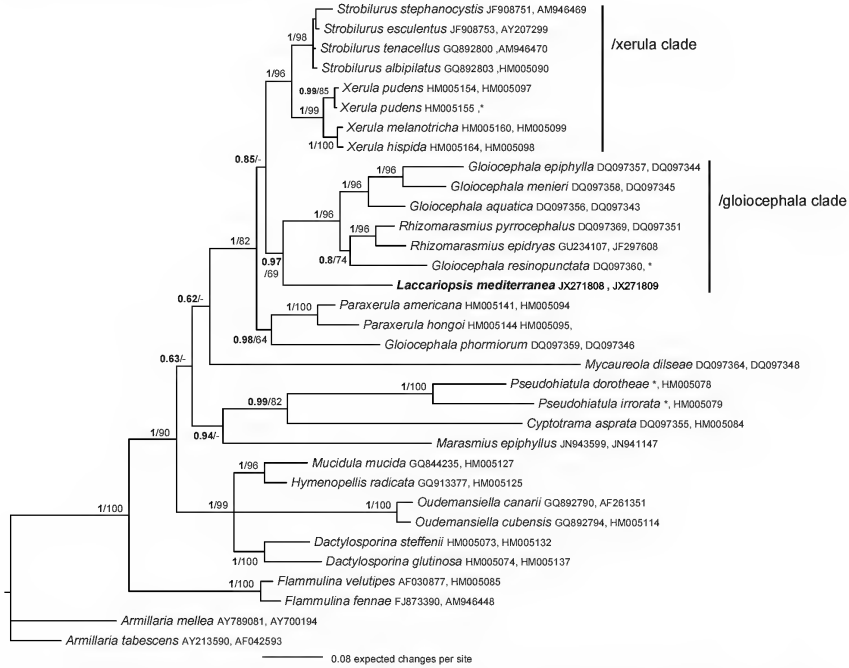

FIGURE 1. Bayesian phylogram obtained from the combined ITS-LSU sequence alignment. Support values for clades that are supported in either the Bayesian (Posterior Probabilities values – BPP) and Maximum likelihood (ML Bootstrap percentage – MLB) analyses are indicated. Only BPP values over 0.60 (in bold) and MLB values over 50% are given above branches.

Taxonomy

Laccariopsis Vizzini, **gen. nov.**

MYCOBANK MB 800949

≡ *Xerula* subg. *Ixoflammula* Contu, Micol. Veget. Medit. 15(1): 22 (2000).

A Rhizomarasmio *et* Gloiocephala *differt habitu* Laccariae *vel* Omphalinae, *pileo viscido, pili cute laxe hymenodermica, basidia, cheilo- atque pleurocystidia crassotunicata et in stuctura molecularis (ITS-spatiis internis transcriptis et LSU DNA).*

TYPE SPECIES — *Hydropus mediterraneus* Pacioni & Lalli

ETYMOLOGY — named in reference to its *Laccaria*-like habit.

Basidiomata agaricoid resembling those of *Laccaria* spp.; lamellae thick, stipe deeply rooting (with long pseudorhiza), slightly viscid, pruinose only at apex, veils absent, spore-print whitish; spores large, thin- to thick-walled, smooth, inamyloid; basidia large, thin- to thick-walled (sclerobasidia); cheilo- and pleurocystidia abundant, thin- to thick-walled; pileipellis strongly gelatinized, made up of a loose hymeniderm with slender, cryptic, thin to moderately thick-walled pileocystidia; stipitipellis with caulocystidia, localized only at apex, thin- to slightly thick-walled; stipititrama monomitic; clamp-connections present.

FIGURE 2. *Laccariopsis mediterranea*.
Basidiomata on sand (from MCVE 23445). Photo by Matteo Carbone. Bar = 1 cm.

Rhizomarasmius and *Gloiocephala* differ in having a dry stipe, a dense hymeniform pileipellis, thin-walled spores, and shorter and thin-walled basidia; *Flammulina* differs in having a dry entirely velutinous stipe, smaller and usually thin-walled spores and basidia, usually thin-walled cheilo- and pleurocystidia, and well-developed pileocystidia; *Strobilurus* is distinguished by a dry pileus and stipe, a dense hymeniform pileipellis, a sarcodimitic stipe trama, and absence of clamp-connections; *Xerula* is characterized by a dry and velutinous pileus and stipe, a pileipellis consisting of a dense hymeniderm, pigmented and very thick-walled pileosetae, similar caulosetae, and a sarcodimitic stipe trama.

Laccariopsis mediterranea (Pacioni & Lalli) Vizzini, **comb. nov.** FIG. 2

MYCOBANK MB 800950

≡ *Hydropus mediterraneus* Pacioni & Lalli, Micol. Ital. 14(1): 5 (1985).

≡ *Flammulina mediterranea* (Pacioni & Lalli) Bas & Robich, Persoonia 13(4): 489 (1988).

≡ *Oudemansiella mediterranea* (Pacioni & Lalli) E. Horak, Riv. Micol. 31(1–2): 34 (1988).

≡ *Xerula mediterranea* (Pacioni & Lalli) Quadr. & Lunghini, Quad. Accad. Naz. Lincei 264: 112 (1990).

≡ *Xerula mediterranea* (Pacioni & Lalli) Ballero & Contu, Arch. bot. ital. 66(3–4): 148 (1990), comb. superfl.

SELECTED DESCRIPTIONS — Robich (1986: 199–202); Bas & Robich (1988: 489–494); Horak (1988: 31–37); Pancorbo & Ribes (2010: 290–291); Petersen & Hughes (2010: 514–515).

SELECTED ICONOGRAPHY — Robich (1986: 201); Rocabruna (1988: 321); Ludwig (2001b: tab. 187, 89.3).

MATERIAL STUDIED: **ITALY**, **LAZIO**, LATINA, Parco Nazionale del Circeo, Sabaudia, coastal sand dunes, associated with *Ammophila littoralis*, 20 Nov 1977, leg. G. Pacioni, Flora Micologica del Circeo no. 402 (Holotype, AQUI 5273); **TUSCANY**, PISA, Parco Naturale Migliarino–San Rossore–Massaciuccoli, Vecchiano, Marina di Vecchiano, under *Juniperus macrocarpa*, 24 Nov 2008, leg. et det. M. Carbone (MCVE 23445); 12 Nov 2011, leg. et det. A. Pierotti (AP2011111204, TO AVP378).

ECOLOGY & DISTRIBUTION: terrestrial, gregarious, associated with *Ammophila littoralis* and/or *Juniperus macrocarpa*/*J. phoenicea* in dune ecosystems. On the Italian Mediterranean coast, it is often typical of the *Ephedro fragilis-Juniperetum macrocarpae* Bartolo et al. vegetation association (Lantieri et al. 2009). Fruiting in winter. The species is saprobic probably on buried dead plant parts: Filippi (1991) reported for Tuscany dune collections a close association between the pseudorhizae (geopodia sensu Jacques–Félix 1967) and dead roots of *Juniperus macrocarpa* and *J. phoenicea*. Gonou-Zagou & Atsa (2011) refer to it as a possibly phoenicoid fungus whose growth and fruiting is stimulated after a fire. So far it is known from Mediterranean coastal dunes of Italy's east and west coasts (Sardinia and Sicily included) (Dal Savio 1984, Pacioni & Lalli 1985, 1986; Contu 1986, 1988, 2000; Robich 1986, Ballero & Contu 1990, Quadraccia & Lunghini 1990, Filippi 1991, Contu & Signorello 1999, Franchi et al. 2001, 2006; Monti et al. 2001, Lantieri et al. 2009, Bizio 2010), Spain and Balearic Islands (Rocabruna 1988, Ortega et al. 1991a, Siquier et al. 2009, Pancorbo & Ribes 2010, 2011), Greece (Gonou-Zagou & Atsa 2011), Tunisia (Pacioni & Lalli 1985, 1986), and from Atlantic coastal dunes of France (Guinberteau & Courtecuisse 1993, Guinberteau 2011) and Spain (Ortega et al. 1991a,b).

Discussion

Our ITS- and LSU-based phylogenetic analyses (FIG. 1) indicate the monospecific *Laccariopsis* as a new evolutionary line in *Physalacriaceae* where with *Gloiocephala* and *Rhizomarasmius* it forms the /gloiocephala clade, which is sister to the /xerula clade (*Strobilurus* and *Xerula*). These two clades were also informally pointed out by Binder et al. (2006).

Laccariopsis mediterranea is defined by a peculiar combination of macro- and micromorphological features, such as: 1) a clearly viscid, not striate pileus (often covered by strongly adhering sand particles); 2) distant and thick subdecurrent lamellae; 3) a strongly rooting stipe (incorporating plant debris and sand particles), pruinose only at apex, slightly viscid downwards; 4) long thin- to thick-walled spores, ellipsoid to subamygdaliform (11–16 × 8–11 µm); 5) long thin- to thick-walled basidia (52–80 × 10–14.5); 6) a pileipellis consisting of a loose ixohymeniderm with slender cylindrical to lageniform pileocystidia; 7) cheilo- and pleurocystidia protruding, thin- to thick-walled,

fusiform to lageniform; 8) thin- to slightly thick-walled and colourless septate caulocystidia confined to stipe apex; 9) a monomitic stipe trama; 10) abundant clamp-connections; 11) habitat in coastal dunes (our observations; and Bas & Robich 1988, Horak 1988, Contu 2000, Ludwig 2001a, Antonín & Noordeloos 2010, Pancorbo & Ribes 2010, Petersen & Hughes 2010).

Oudemansiella oreina Pacioni & Lalli (≡ *Xerula oreina* (Pacioni & Lalli) Contu), known only from the type collection from Simbruini Mountains, Abruzzi (Centre Italy) and not treated in Petersen & Hughes (2010), could possibly belong to *Laccariopsis*; it differs from *L. mediterranea* in having a collybioid/*Flammulina*-like habit (Bon 1999 considered it a *Flammulina*) with more crowded and non-decurrent lamellae, a striate pileus margin, a brown-purplish and entirely velutinous stipe, slightly smaller and strictly ellipsoid spores (9–14 × 7–9 µm), and growth in grass-covered mountain areas (Pacioni & Lalli 1989, Bon 1999, Contu 2000). Molecular data are needed to determine the taxonomic status of this species.

As regards morphological affinities at the generic level, *Laccariopsis, Gloiocephala,* and *Rhizomarasmius* (/gloiocephala clade) share a monomitic stipe trama (Redhead 1987, Horak & Desjardin 1994, Petersen 2000) and similar pileipellis structure and cystidia (Petersen 2000, Antonín & Noordeloos 2010). *Gloiocephala* differs in having basidiomes with a gracile marasmioid habit, a dry to subviscid pileus, a insititious to pseudoinsititious non-rooting stipe that is often short lateral or eccentric and usually entirely pruinose, a lamellate to reduced-smooth hymenophore, a dense hymeniform pileipellis, thin-walled spores, shorter and thin-walled basidia, and growth on herbaceous plant or wood leaves, stems, and debris, usually in wet places (Bas 1961, Redhead 1981, Singer 1986, Horak & Desjardin 1994, Desjardin et al. 1995, Antonín 2007, Tkalčec & Mešić 2008, Antonin & Noordeloos 2010). *Rhizomarasmius* is distinguished by basidiomes with a marasmioid habit, a dry pileus surface, a minutely and entirely pruinose-hairy stipe darkening downwards to brown-blackish, a ramified pseudorhiza (= rhizomorphic pseudorhiza sensu Norvell 1998), thin-walled spores, thin-walled shorter basidia, thin-walled hymenial cystidia, and a dense hymeniform pileipellis (Petersen 2000, Antonín & Noordeloos 2010, Ronikier & Ronikier 2011).

In the close /xeruloid clade, *Strobilurus* is characterized by a dry pileus surface, a stipe deeply rooting on buried hypogeous or superficial strobiles of conifers, on conifer wood, or on *Magnolia* fruits, a pileipellis consisting of a dense hymeniderm, thin-walled and shorter spores and basidia, a sarcodimitic stipe trama, and absence of clamp-connections (Wells & Kempton 1971, Redhead 1980, Singer 1986, Desjardin 1987, Noordeloos 1999, Gulden 2008). *Xerula* s.s. has a dry and velutinous pileus, an entirely velutinous-hispid rooting stipe, a pileipellis consisting of a dense hymeniderm with up to 1.5 mm long,

rigid and very thick-walled (≤6 µm thick) brown pileosetae, similar caulosetae, a sarcodimitic stipe trama, and clamp-connections (Petersen & Hughes 2010).

Finally, among the phylogenetically unrelated *Physalacriaceae,* the morphologically close genus *Flammulina* shares with *Laccariopsis* a viscid pileus, a similar pileipellis structure (in the extra European taxa), and a monomitic stipe trama, but differs in having a dry entirely velutinous stipe, well-developed pileocystidia, smaller and usually thin-walled spores and basidia, and usually thin-walled hymenial cystidia (Bas 1983, 1995; Redhead et al. 1999, 2000; Redhead & Petersen 1999, Ge et al. 2008, Petersen et al. 2012).

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Amanita chocoana—a new species from Ecuador

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Abstract — *Amanita chocoana*, an interesting new species of section *Vaginatae*, is described from the Chocó region of Ecuador.

Key words — *Agaricales*, *Amanitaceae*, Estación Biológica Bilsa, neotropics

Introduction

The Chocó, or Chocó/Darien/Western Ecuador, is a world "biodiversity hotspot" now covering only 24% of the original 260,000 km^2 forest (Myers et al. 2000). Extending throughout Colombia, Ecuador, Panama, and Peru, the Chocó has an exceptionally high concentration of endemic tree and animal species and urgently requires political support for conservation (Myers et al. 2000, Brooks et al. 2002, Sierra et al. 2002). To date, agarics have been reported mostly from the Colombian portion of the biome (e.g. Franco-Molano 1993, Guzmán et al. 2004, Franco-Molano et al. 2010).

The diversity of *Amanita* Pers. in tropical South America is not yet well known. Only two amanitas have been reported from Ecuador: *A. craseodermata* [sic; probably *A. craseoderma* Bas] and *A. fuscostriata* Pegler from the state of Cuyabeno, growing in a 'terra firme' forest in the Ecuadorian Amazon (Lunt & Hedger 1996). However, this genus is widely reported from neighboring countries such as Bolivia (Bas 1969), Andean Colombia (Tulloss et al. 1992, Tulloss & Franco-Molano 2008), Guyana (Simmons et al. 2002), and most recently Brazil (Wartchow & Maia 2007, Wartchow et al. 2007, 2009, Menolli et al. 2009a,b). We present here a new species of *Amanita* from Ecuador, collected within the Chocó biome.

Materials & methods

The collection site

The Bilsa Ecological Station (0°21′33″N 79°42′02″W, alt. 300–750 m) lies within the Chocó region in Esmeraldas Province on the northwest coast of Ecuador near the Mache-Chindul Ecological Reserve. The 3300 km^2 area comprises 80% mature forest and has an annual rainfall of 1500 to 2000 mm (Ortega-Andrade et al. 2010).

The vegetation on the collection site belongs to "coastal foothill evergreen forest" (Sierra 1999), "moist foothill forest" (Cañadas 1983), and "semi deciduous forest" (Holdrige 1967) that fit into the "Sector de la Cordillera Costera", a mountain range that lies east of the city of Esmeraldas, north of the Esmeraldas River (Sierra 1999).

Trees over 30 m tall are relatively abundant on the station and reach to the top (600–800 m alt.) of the coastal range in Esmeraldas and northern Manabí provinces. The Chocó separates the wet northern region from the dry southern coastal area. Characteristic flora includes *Caryodaphnopsis theobromifolia* (*Lauraceae*); *Carapa guianensis* (*Meliaceae*); *Matisia soegengii* (*Bombacaceae*); *Pourouma bicolor, Coussapoa villosa (Cecropiaceae); Perebea xanthochyma* (*Moraceae*); *Chamaedorea pinnatifrons, C. poeppigiana, Iriartea deltoidea* (*Arecaceae*); *Eschweilera rimbachii* (*Lecythidaceae*); and *Faramea occidentalis* (*Rubiaceae)* (Cerón et al. 1999).

Abbreviations

For the biometric values, we follow Tulloss & Lindgren (2005), except that on editorial suggestion we changed the font originally proposed by Tulloss as follows: $\mathbf{w}_{cs}$ = breadth of central lamellar stratum; $\mathbf{w}_{st}$**-near** = distance from one side of central stratum to the nearest basidium base; $\mathbf{w}_{st}$**-far** = distance from one side of central stratum to most distant basidium base on the same side; L, (W) = range of average spore lengths (widths) in each examined basidioma; L', (W') = average of all spore lengths (widths) measured in all basidiomata; Q = length to width ratio per spore or range of such ratios for all spores measured; Q' = average Q value per specimen examined and the range of such averages; Qm = average Q value computed for all spores measured.

Herbarium codes follow Thiers (2011). Generic and infrageneric names and concepts follow Corner & Bas (1962) and Bas (1969), as modified by Yang (1997).

Taxonomy

Amanita chocoana Wartchow, **sp. nov.** FIGURES 1-4

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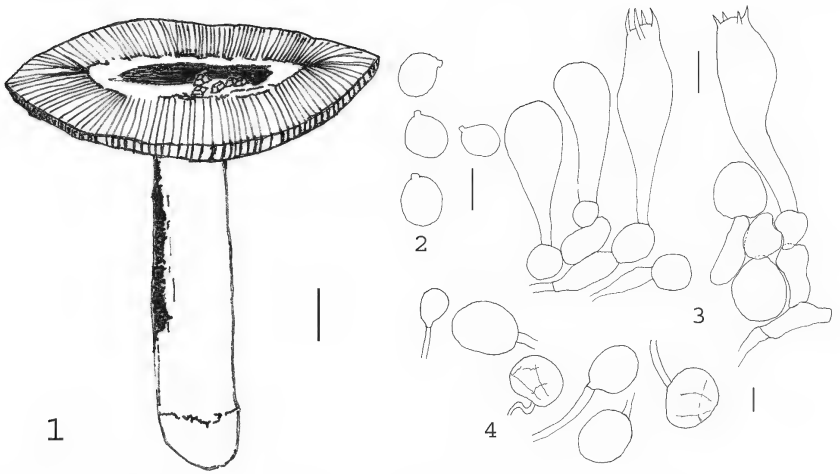
Differs from *Amanita colombiana* in the reddish brown pileus with pale margin, pyramidal velar remnants with yellowish tips, relatively stout stipe, and the subglobose to ellipsoid basidiospores.

TYPE: Ecuador, Prov. Esmeraldas, Mun. Esmeraldas, Bilsa Biological Station, 23.xi.2005, J.P. Gamboa-Trujillo, L. Carrasco & D. Cabrera s.n. (**Holotype**, QAP 72474; **isotype**, URM 82094).

ETYMOLOGY: *chocoana*, referring to the Chocó biome, within which the new species was collected.

Basidiomata solitary, medium size, rather stout, fragile. PILEUS: ranging to 60 mm in diam., plano-convex, brown to dark reddish brown at centre (between



Figs. 1–4. *Amanita chocoana*. 1. Basidioma (holotype). Scale bar = 10 mm. Figs. 2–4. (isotype) Scale bar = 10 µm.. 2. Basidiospores. 3. Basidium, basidioles, and subhymenium. 4. Universal veil from stipe base.

'cigar brown 16' and 'snuff brown 17'), paler in smooth zone outside disc, and paler ('clay buff 32') in grooved zone with white inter-striation at margin, glabrous and shiny at centre; MARGIN broadly plicate-striate (>50% of ratio); CONTEXT thin, probably white and unchanging; UNIVERSAL VEIL as scattered friable pyramidal warts whitish at first and then gray toward base with yellowish brown ('buff 52') tip, easily removed. LAMELLAE: probably free, sub crowded, relatively narrow, whitish, with concolorous edge; LAMELLULAE rare. STIPE: ≤80 × 25 mm, tapering in upper portion cylindric in lower part, hollow, cream, fragile, smooth and glabrous; CONTEXT white, unchanging; PARTIAL VEIL absent; UNIVERSAL VEIL as scattered brownish patches at base difficult to distinguish under strong lens (×10) in exsiccatum. Odor and taste not recorded.

BASIDIOSPORES: [90/2/1] (8–)8.5–12(–12.5) × (6.5–)7.5–9.5(–11) µm, L = 10.2–10.8 µm, L' = 10.4 µm; W = 8.2 µm, W' = 8.2 µm; Q = (1.03–) 1.06–1.65 (–1.70); Q' = 1.22–1.32, Qm = 1.25, inamyloid, hyaline, colorless, subglobose to ellipsoid, infrequently elongate or globose, smooth, thin-walled, at least somewhat adaxially flattened, with rounded apex; APICULUS rounded obtuse to subconic, small, sublateral to subapical; CONTENTS monoguttulate. BASIDIA: 30–44 × 11–13 µm, clavate, with 4 or sometimes 2 sterigmata ranging to 6 µm high; clampless. SUBHYMENIUM: rehydrating weakly; cellular, ≤10–25 µm thick 2(–3) layers, sometimes having very small inflated cells from which basidia arise e.g. 10 × 8.5 µm to 14 × 13 µm; $\mathbf{w_{st}}$**-near** = 8.5–15 µm; $\mathbf{w_{st}}$**-far** = ≤12–21 µm. LAMELLA TRAMA: difficult to rehydrate in material, but obviously

bilateral; w_{cs} = ≤25 µm or 35 µm; abundant filamentous hyphae 3–9 µm wide gradually diverging from central stratum, apparently lacking inflated hyphae, unbranched or rarely branched; vascular hyphae absent. Marginal tissue of lamellae: difficult to observe, sterile; apparently two layered, yellowish brown, with the outer layer with some globose cells 10 µm in diam., colorless and very few yellowish brown cells approx. 27 × 20 µm and the internal layer consisting of filamentous hyphae 6 µm wide, parallel to lamella edge. Pileus context: moderately well rehydrated, thin; filamentous hyphae 2.5–8 µm, plentiful, extensively interwoven forming a loose matrix in which other elements occur, commonly branched, septate, clampless; acrophysalides ≤50 × 25 µm, broadly clavate, relatively inconspicuous; vascular hyphae common, traversing the entire context thickness. Stipe context: difficult to rehydrate, but distinctly acrophysalidic; acrophysalides ≤125–187 × 23–32 µm, plentiful, clavate to slender clavate, thin-walled; filamentous hyphae 2–13 µm, longitudinally oriented, rarely branched; vascular hyphae 5–8 µm wide, unbranched, with longitudinal orientation, fairly common. Pileipellis: ≤200 µm thick; suprapellis with hyphae 1.5–5 µm, more or less erect, colorless, thin-walled, immersed in a strong gelatinized matrix; subpellis with hyphae 2.3–7 µm, brown to dark brown, radially oriented; vascular hyphae frequent 7–10 µm, sometimes anticlinal orientation crossing all pileipellis, somewhat arising from pileus context. Universal veil: On pileus—mostly absent in exsiccatum, with at least one dark brown thick-walled geometrically globose cell ≤40 µm. On stipe base—common filamentous hyphae 3–10 µm, densely interwoven, thick-walled, plentiful; terminal globose to pyriform cells with 25–50 × 17–37 µm, grayish to yellowish brown to somewhat brownish, with brownish thick-walled. Partial veil: absent.

Habitat: On soil among members of putatively ectomycorrhizal trees families with the most diverse families being *Leguminosae*, *Myrtaceae*, *Euphorbiaceae*, *Sapotaceae*, *Rubiaceae* and *Melastomataceae*. *Polygonaceae* and *Nyctaginaceae* (both probable neotropical ectomycorrhizal forest elements) have relatively small numbers of species (Gentry 1986).

Remarks: *Amanita chocoana* is characterized by its plicate-sulcate pileus margin, friable grayish pyramidal warts with yellowish buff tips that are pallid at first before becoming grayish brown and easily removed by handling, strongly gelatinized suprapellis, and variably shaped (globose to elongate) basidiospores. The new species belongs to small set of taxa of *Amanita* sect. *Vaginatae* characterized by a very friable universal veil largely disappearing from the stipe base and from which it is separated as follows:

Amanita colombiana Tulloss et al. from Andean Colombia shares the plicate-sulcate pileus margin topped by somewhat flattened pyramidal to conical velar remnants but differs in the initially fulvous remnants that darken

to dark reddish brown or fuscous brown and the dull olive brownish pileus. Its subhymenium, which is "subcellular ramified, on which basidia arise from short branched uninflated to slightly inflated hyphal segments" (Tulloss et al. 1992), contrasts with the somewhat common inflated to sub-inflated subhymenium elements in our new species. In addition, the *A. colombiana* basidiospores fall exclusively into Bas's globose to subglobose categories [106/4/3: (9–)10–12.2 (–14.2) × (8.5–)9.5–12(–14) µm, L = 10.8–11.5 µm, L' = 11.3 µm; W = 10.5–11.1 µm, W' = 10.9 µm; Q = 1.00–1.07(–1.17); Q' = 1.03–1.04, Qm = 1.03; Bas 1969]. *Amanita columbiana* is further separated by its probable host, *Quercus* (Tulloss et al. 1992) in the *Fagaceae*, which does not occur in the Chocó (Gentry 1986, Galeano et al. 1998, Cárdenas-López 2003). Colombia is the southern limit for *Quercus*-associated amanitas (Tulloss 2005).

Amanita cinctipes Corner & Bas from Malaya and Singapore resembles *A. chocoana* in having erect, ≤25 mm high pyramidal warts but differs in its mouse-gray to pale grayish pileus and globose to subglobose basidiospores 8–11.1 × 7.8–10.1 µm, Q = 1.00–1.10, Qm = 1.05 (Corner & Bas 1962).

The European *A. ceciliae* (Berk. & Broome) Bas differs in the yellow-brown pileus that darkens to brown with dingy gray-white to blackish velar remnants in old specimens, a short striate margin, and globose to subglobose basidiospores 10.4–14.1 × 9.7–14 µm, Q = 1.00–1.10 (Breitenbach & Kränzlin 1995).

Amanita sororcula Tulloss et al. from Andean Colombia differs in its pileus with whitish to gray to tannish gray appressed patches and globose to subglobose basidiospores [160/6/4: (8.2–)9.7–12.8(–16.8) × (8–)8.8–12(–15.5) µm, L = 10.2–12.1 µm, L' = 11 µm, W = 9.3–11.5 µm, W' = 10.2 µm, Q = (1.00–) 1.01–1.16(–1.25), Q' = 1.05–1.10, Qm = 1.07, Tulloss et al. 1992].

Amanita antillana Dennis from Trinidad and Martinique also has a strongly gelatinized pileipellis and similar basidiospores [40/1/1: (8.4–)9.8–13.3(–14.3) × (7.1–)7.7–10.5(–11.9) µm, L' = 11.2 µm, W' = 9.1 µm; Q' = (1.08–)1.09–1.40(–1.42), Qm = 1.24], although the Q range suggests narrower basidiospores; *A. antillana,* however, differs in the olive brown pileus, pulverulent velar remnants with thin-walled inflated colorless cells, and pileipellis hyphae (Pegler 1983, Tulloss 1994).

Amanita calopus (Beeli) E.-J. Gilbert from Central Africa resembles *A. chocoana* in the brownish tinted pileus but differs in its more elongate spores (10–14 × 7–9 µm, L' = 11.7 µm, W' = 7.7 µm, Qm = 1.50), slender stipe, pinkish gray lanose-floccose pyramidal to floccose pileus patches, and pseudoparenchymatous subhymenium (Pegler & Shah-Smith 1997).

Amanita conicogrisea A.E. Wood from Australia is a confused species. Wood (1997) placed it in the section *Amanita*, but the lack of swollen base reported in the protologue and illustrated in Wood's figure strongly suggest that a reclassification to section *Vaginatae* may be needed. The very short

A. conicogrisea description suggests that it differs from *A. chocoana* in its dull cream to cream-gray pileus with concolorous conical warts, slightly striate pileus margin, and a fairly slender stipe with velar remnants appearing as "little fibrillose margin on upper portion" (Wood 1997). Microscopic details are not sufficiently informative for comparison; the *A. conicogrisea* basidiospores are more or less similar in size (9.9–11.7 × 7.2–8.7 µm, Qm = 1.34) to our new species, the inflated cells of the universal veil are 30–40 µm in diam., and the pigment (not noted) is probably absent.

Amanita craseoderma from North Brazil differs in its non-gelatinized pileipellis elements organized somewhat as terminal clavate cells, very small irregularly shaped dark gray-brown velar remnants on the pileus, cellular subhymenium, and globose to subglobose basidiospores (10/1/1: 7.5–9 × 7–8 µm, Q = 1.05–1.15, Qm = 1.10; Bas 1978). *Amanita craseoderma* sensu Pegler (1983) from Martinique was reported with longer narrower spores (8.5–12 × 7.5–8.8 µm, L' = 9.7 µm, W' = 8 µm, Q' = 1.20) than Bas (1978); the similarity of Pegler's L', W', and Q' values suggests a relationship between his material and *A. chocoana,* but the Martinique material does differ in the small verrucose velar remnants and slender stipe.

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Heteroconium bannaense sp. nov. and a new record of the genus from China

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Abstract — Two species of the anamorphic genus *Heteroconium* were discovered from tropical forests in southern China. *Heteroconium bannaense* sp. nov. is described and illustrated based on a specimen collected on dead stems of *Phragmites communis*. *Heteroconium arundicum* is newly recorded from China.

Key words — conidial fungi, taxonomy

Introduction

Heteroconium was established by Petrak (1949) with *H. citharexyli* Petr. as the type species. The genus is characterized by distinct, single conidiophores with monoblastic, terminal, determinate or percurrently extending conidiogenous cells that produce catenate, euseptate conidia. The conidiophores are unbranched or with a secondary branch originating after conidial secession or near a percurrent proliferation (Petrak 1949, Castañeda et al. 1999, 2008, Taylor et al. 2001). The criteria used for species delimitation in *Heteroconium* are primarily based on conidial morphology and size. Castañeda et al. (2008) compared *Heteroconium* with several other similar genera, including *Cladophialophora* Borelli, *Lylea* Morgan-Jones, *Phaeoblastophora* Partr. & Morgan-Jones, *Septonema* Corda, *Taeniolella* S. Hughes, and *Xenoheteroconium* Bhat et al. To date, 24 legitimate names have been included under *Heteroconium* (MycoBank 2012, Ma et al. 2012a,b, Ren et al. 2012). However, *Heteroconium chaetospira* (Grove) M.B. Ellis, *H. solaninum* (Sacc. & P. Syd.) M.B. Ellis, and *H. tetracoilum* (Corda) M.B. Ellis have been transferred to other hyphomycete genera (Holubová-Jechová 1978, Crous et al. 2007, Hughes 2007), and *H. queenslandicum* Matsush. is considered probably to belong in the genus *Parapleurotheciopsis* P.M. Kirk (Castañeda et al. 2008). Thus, *Heteroconium* currently has 20 accepted taxa. Six species, *H. annesleae* S.C. Ren & X.G. Zhang, *H. fici* L.G. Ma & X.G. Zhang, *H. neolitseae* S.C. Ren & X.G. Zhang,

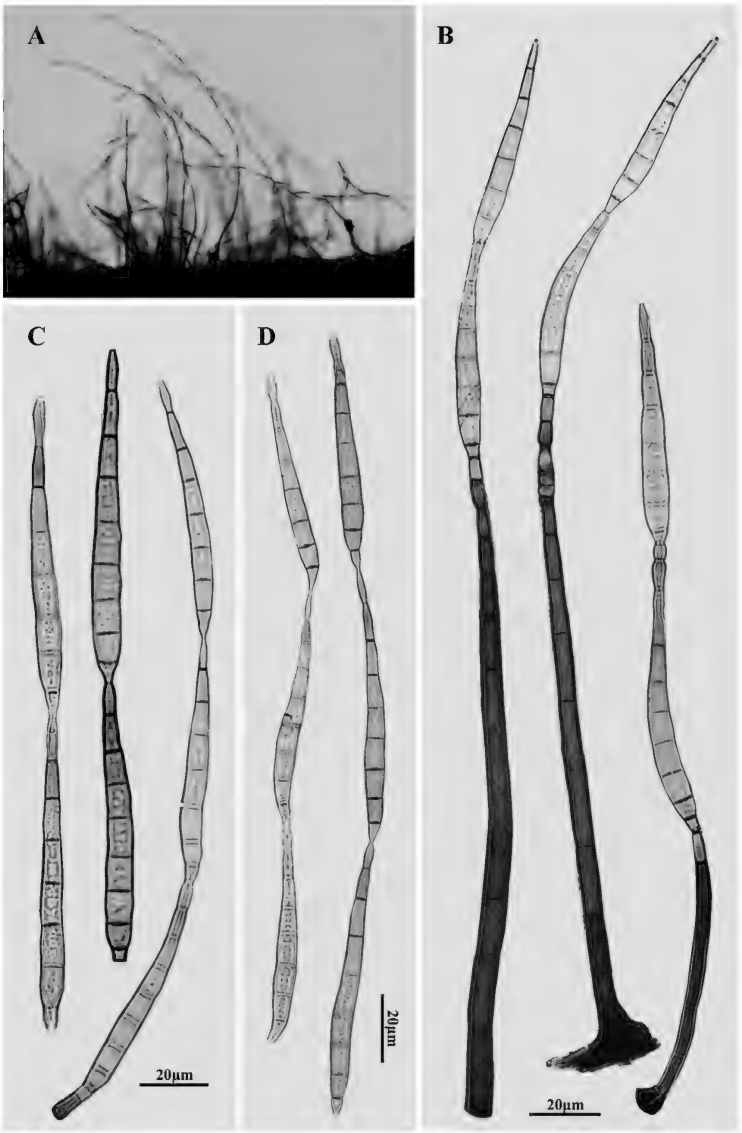

Fig. 1. *Heteroconium bannaense.*
A. Colonies on natural substratum. B. Conidiophores with conidia. C, D. Conidia.

H. phellodendri J.Ma & X.G. Zhang, *H. schimae* Y.D. Zhang & X.G. Zhang, and *H. tsoongiodendri* L.G. Ma & X.G. Zhang have been previously described from China (Zhang et al. 2010, Ma et al. 2012a,b, Ren et al. 2012).

During our ongoing survey of anamorphic fungi associated with woody debris in tropical forests of southern China, two species with morphological characteristics of genus *Heteroconium* were collected on decaying twigs and dead stems. One species is proposed herein as a new species, while the other is a new record for China.

Heteroconium bannaense J.W. Xia & X.G. Zhang, **sp. nov.** Fig. 1

MycoBank MB 801029

Differs from all other *Heteroconium* species in its typical obclavate conidia with both eusepta and distosepta.

Type: China, Yunnan Province: Xishuangbanna, on dead stems of *Phragmites communis* Trin. (*Poaceae*), 2 Nov 2011, J.W. Xia (**Holotype**, HSAUP H6035; **isotype**, HMAS 243411).

Etymology: in reference to the type locality.

Colonies on natural substrate effuse, dark brown, hairy. Mycelium partly superficial, partly immersed in the substratum, composed of septate, pale brown, smooth, 1–2 µm wide hyphae. Conidiophores macronematous, mononematous, unbranched, erect, straight or slightly flexuous, cylindrical, smooth, thick-walled, brown, 6–11-septate, 76.5–197 × 3–7 µm. Conidiogenous cells monoblastic, integrated, terminal, cylindrical, determinate or percurrent, brown, smooth, truncate at the apex, 6.5–8 × 2.5–3.5 µm. Conidial secession schizolytic. Conidia holoblastic, acrogenous, blastocatenate, in chains of up to 9, straight or slightly curved, obclavate, brown, smooth, 14–22-septate (6–8-euseptate, 8–14-distoseptate), 58–93.5 µm long, 5–8 µm wide, truncate at the base.

Comments – Among the known species, *Heteroconium bannaense* bears some resemblance in conidial shape to *H. tropicale* R.F. Castañeda & W.B. Kendr. (Castañeda & Kendrick 1990). However, the conidia of *H. bannaense* are larger than those of *H. tropicale* (conidia 26–52 × 4–6 µm, 3–6-euseptate), and have more septa. In addition, *H. bannaense* is unique within the genus in its typical obclavate conidia with both eusepta and distosepta.

Heteroconium arundicum Chowdhry, Indian Phytopath. 33: 361, 1981 ["1980"]. Fig. 2

Colonies on natural substrate effuse, brown to blackish brown, hairy. Mycelium mostly immersed in the substratum. Conidiophores macronematous, mononematous, solitary or in groups, sometimes branched, erect, straight to flexuous, cylindrical, septate, brown, smooth, up to 180 × 5.5–7.5 µm. Conidial secession schizolytic. Conidia holoblastic, acrogenous, blastocatenate, straight or slightly curved, cylindrical to fusiform, brown, smooth, 3–8-euseptate, 56–110 µm long, 7.5–11 µm wide, truncate at base.

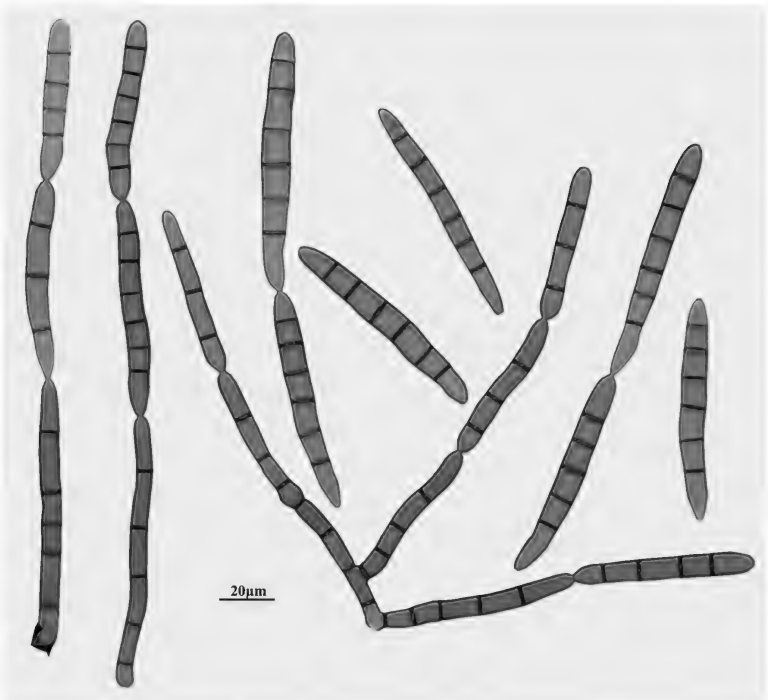

Fig. 2. *Heteroconium arundicum.*
Conidiophores and conidia.

Specimen examined: **CHINA, Hainan Province**: Lingao, on decaying twigs of unidentified broad-leaved tree, 10 April 2011, J. Ma (HSAUP H5493-2, HMAS 243412).

Comments – *Heteroconium arundicum* is reported for the first time from China. Compared with the type material described by Chowdhry (1981), the conidiophores of Chinese specimen are occasionally branched, but other features of this taxon closely match those of the original description. *Heteroconium arundicum* is similar to *H. citharexyli* (Petrak 1949) in conidial shape, but differs in having larger conidia (56–110 × 7.5–11 μm vs. 10–40 × 3–7 μm).

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Mycobilimbia and *Rinodina* species new to Turkey

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Abstract — *Mycobilimbia pilularis* and *Rinodina balanina* were determined as new to Turkey and the Middle East following a recent lichenological foray in Iğdır region (Turkey). Geographic distribution, substrate, chemistry, and comparisons with morphologically similar taxa are presented.

Key words — *Ascomycota*, biodiversity, lichen

Introduction

Recently, many new lichen taxa have been recorded for the lichen mycota of Turkey (e.g. Candan & Halici 2009, Halici & Aksoy 2009, Karagöz et al. 2011, Kinalioglu 2010a,b, Kinalioglu & Aptroot 2010, Osyczka et al. 2011, Yazici & Aslan 2009, Yazici et al. 2010a,b,c, 2011a,b). Nonetheless, in comparison to that from other European countries, many regions of Turkey remain poorly known. Only two papers (Yazici et al. 2011a, 2012) have previously reported lichens from Iğdır region.

During a recent excursion in Iğdır region (Turkey), we sampled some lichens, among which *Mycobilimbia pilularis* and *Rinodina balanina* were determined as new to Turkey. Two *Mycobilimbia* taxa and 52 *Rinodina* taxa have previously been reported from Turkey.

Iğdır is one of the poorest forested areas in Turkey and is dominated by steppe, which is covered by rich grassy plants. Hoşhaber village and the southern Halfeli district are exposed to high light conditions and is a windswept open area with gently sloped terrain dominated by grass, rocks, and streams (Baytop & Denizci 1963). The climate in the Iğdır region is characterized by hot, dry summers and cold, snowy winters. The mean annual temperature is 11.6 °C, humidity is 63%, and the mean annual rainfall is 257.6 mm. Summers are characterized by moderate precipitation and the winters generally by high precipitation (Akman 1999).

Material & methods

Lichen samples were collected during a March 29–July 12, 2010, lichenological research foray in the Iğdır region. Air-dried samples were examined with Nikon SMZ1500 stereomicroscope and a Nikon Eclipse 80i light microscope. Secondary metabolites and identifications were determined by consulting the literature (Dobson 2005, Poelt 1974, Poelt & Vězda 1981, Thomson 1997, Wirth 1995). The descriptions are based on our examined specimens and our own observations.

Vouchers are stored in the herbarium of the Biology Department, Karadeniz Technical University, Trabzon, Turkey (KTUB).

Species recorded

Fig. 1. *Mycobilimbia pilularis,* habitus. Scale= 1mm.

Mycobilimbia pilularis (Körb.) Hafellner & Türk, Stapfia 76: 153.2001 Fig 1

Thallus thin, finely granular-effuse, green-white to greenish-gray, resembling granules. Apothecia lecideine (biatorine), pink-orange or buff coloured about 0.4–0.6 mm in diam.; discs plane at first, then convex with proper margin excluded, often clustered with pale orange-pink to pale reddish-brown. Immature apothecia have pale, slightly prominent margins. Asci cylindrical-clavate, 8-spored; ascospores colourless, oblong-fusiform, smooth, 1-septate (a few old spores 3-septate), 15–17(–19) × 4.5–6.0 µm. Hymenium, hypothecium and epithecium colourless. Thallus and cortex K–, C–, KC–, P–. Pycnidia absent. Photobiont chlorococcoid.

Mycobilimbia pilularis found growing on mosses near the stream in a little pitched canyon. It grows on near the bases of mossy bark of mature deciduous

ash (*Fraxinus*) and oak (*Quercus*) trees, on the trunks in humid valleys, rarely on mosses over sandstone rock by streams in humid forests, and on soil especially near tree trunk bases in humid forests. Usually epiphytic, *M. pilularis* may rarely grow on rocks from the submediterranean belt to the oroboreal belt of the Alps. Previously known from Europe, North America, and Asia (Smith et al. 2009). New to Turkey and the Middle East.

Specimen examined: **TURKEY. Iğdır:** Center, Hoşhaber village-Kızkabir, 39°52′33.08″N 43°51′59.60″E, on mosses near the stream in a little pitched canyon, 1370m, 29.03.2010, KTUB 2105.

Remarks — *Mycobilimbia pilularis* is similar to *Bilimbia sabuletorum* (Schreb.) Arnold and *Mycobilimbia carneoalbida* (Müll. Arg.) S. Ekman & Printzen, but *B. sabuletorum* has a greenish epithecium, brown hypothecium. tan apothecia that become brown or blackish, and 3–5-septate spores (14–)18–27 × 5–6 µm. *Mycobilimbia carneoalbida* is distinguished by 3-septate ascospores.

Fig. 2. *Rinodina balanina,* habitus. Scale= 1mm.

Rinodina balanina (Wahlenb.) Vain., Ark. Bot. 8(4): 69.1909 Fig 2

Thallus placodioid, rosette-forming, up to 3–4 cm wide, brown to gray-brown, isidiate-sorediate, radial effigurate, slightly frosted appearance; marginal lobes thick, irregularly branched (divided-notched), to 0.4 mm wide, 1–2 mm long, contiguous, inner part globulose-areolate, covered with round, closely flaky-warty aggregated, short isidia (appearance of dense isidia-pad) towards the center or with frequent coarse soredia. Apothecia 0.1–0.5 mm diam. Asci

clavate, 8-spored; ascospores *Orcularia*-type, 15–18 × 9–11µm. Thallus and cortex K–, C–, KC–, P–. Photobiont *Trebouxia*.

Rinodina balanina grows on well-manured, bird-dunged rocks along arctic shores, common. Previously known from Europe, Asia, and North America (Thomson 1997). New to Turkey and the Middle East.

Specimens examined: **TURKEY. Iğdır:** Center, south of Halfeli town, 39°51′54.84″N 43°56′53.53″E, on calcareous rock, 1180 m, 29.03.2010, KTUB 2103.

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New records of smut fungi. 7

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Abstract — Three new species of smut fungi from North America are described and illustrated: *Anthracoidea deweyanae* on *Carex deweyana* from U.S.A., *A. foeneae* on *Carex foenea* from Canada, and *A. savilei* on *Carex norvegica* from Canada. *Anthracoidea shaanxiensis* is reported for the first time from North America (Canada) on a new host plant, *Carex concinna*. This species has been known only from Chinese localities.

Key words — *Anthracoideaceae*, taxonomy, *Ustilaginomycetes*

Introduction

A revision of *Anthracoidea* specimens, on loan from the National Mycological Herbarium, Agriculture and Agri-Food Canada (DAOM), yielded three new records for Canada and one for U.S.A. For each of those countries, 32 *Anthracoidea* species have been recorded to date (Denchev & Denchev 2011; Vánky 2011a,b; Vánky & Salo 2011). We propose three new species of *Anthracoidea* on *Carex* spp. from sections *Deweyanae, Ovales,* and *Racemosae,* based on the fact that *Anthracoidea* species are restricted to host plants in the same or closely related *Carex* sections (Vánky 1979).

Material & methods

Dried specimens from DAOM were examined under light (LM) and scanning electron (SEM) microscopes. For LM observations, spores were mounted in lactophenol solution on glass slides, gently heated to boiling point to rehydrate the spores, and then cooled. Spore measurements are given in the form: min–max (extreme values, if necessary) [mean ± 1 standard deviation]. For SEM, spores were attached to specimen holders by double-sided adhesive tape and coated with gold with an ion sputter. The surface structure of spores was observed at 10 kV and photographed with a JEOL JSM-5510 scanning electron microscope.

New records

Anthracoidea deweyanae Denchev & T. Denchev, **sp. nov.** FIGS 1–4

MYCOBANK MB 564919

Differs from all other *Anthracoidea* species by specialization on *Carex* sect. *Deweyanae.*

TYPE: on *Carex deweyana* Schwein.: U.S.A., California, Tehama Co., Brokeoff Mountain Trail, Lassen Volcanic National Park, 18 August 1957, leg. W.B. & V.G. Cooke, no. 30919 (**holotype,** DAOM 167 093).

ETYMOLOGY: the name refers to the host species.

SORI in ovaries, scattered in the inflorescence, as broadly ellipsoidal or subglobose, black, hard bodies, 1.5–2.5 mm long, when young covered by a thin membrane, later becoming exposed; spore mass of the mature sori powdery on the surface. SPORES flattened, in plane view orbicular, suborbicular, broadly elliptical or oval, sometimes slightly irregular, in plane view 17–21.5 × 15–20.5 [19.3 ± 0.9 × 17.6 ± 1.2] µm (n = 100), in side view 11.5–13.5 µm thick, medium reddish brown, wall more or less evenly thickened, 1.0–1.4 µm thick, sometimes 1–3 internal swellings present, light-refractive spots absent; in LM verruculose, warts up to 0.3 µm high, spore profile not or slightly affected. SPORE GERMINATION unknown.

DISTRIBUTION — On *Cyperaceae: Carex* sect. *Deweyanae: Carex deweyana.*

COMMENTS — *Carex deweyana* is a North American species, distributed in Canada and U.S.A. It belongs to *Carex* sect. *Deweyanae,* which includes eight species from North America and East Asia (Naczi 2002, 2009). As no *Anthracoidea* species has previously been reported on a representative of that section, we propose a new species.

Anthracoidea foeneae Denchev & T. Denchev, **sp. nov.** FIGS 5–8

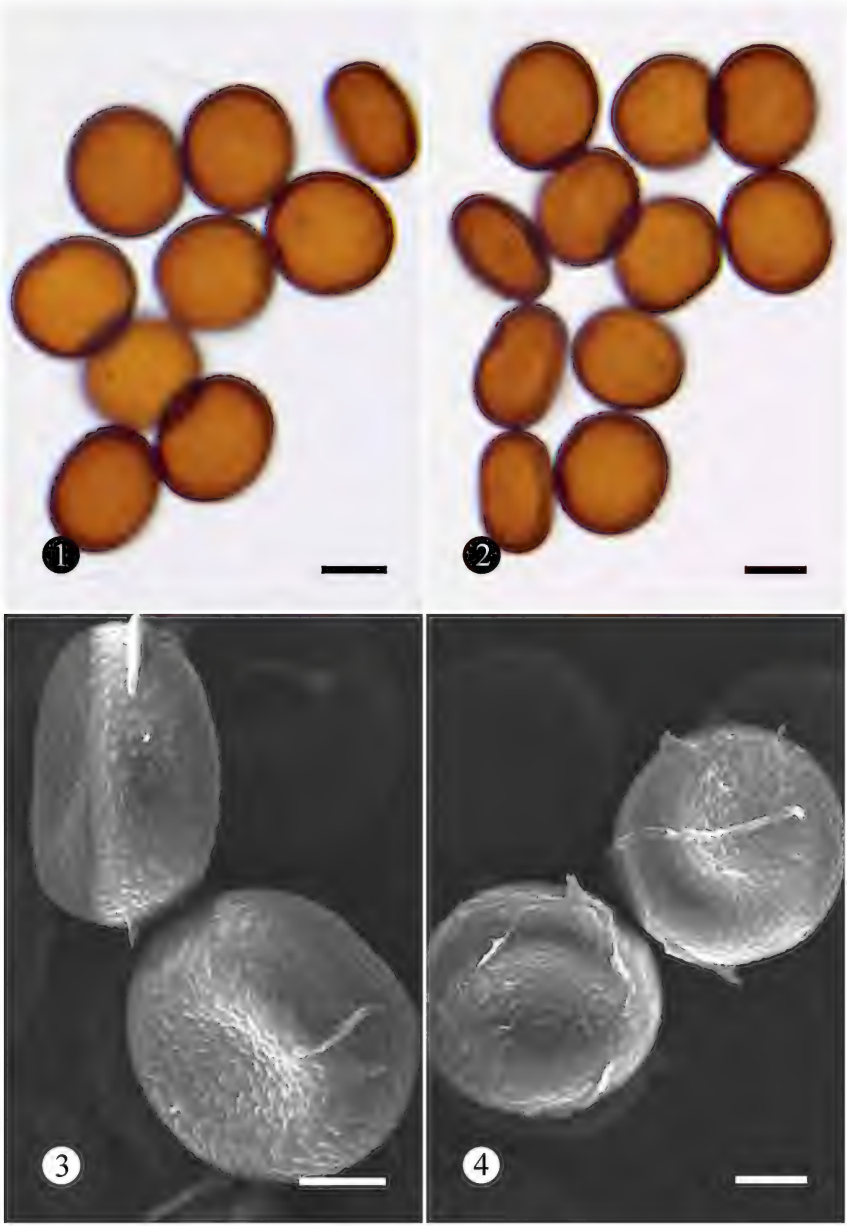
MYCOBANK MB 564920

Differs from other *Anthracoidea* species on sedges in *Carex* sect. *Ovales* by having a spore wall 1.3–3.0(–3.5) µm thick, lacking internal swellings and light-refractive spots, and having verruculose ornamentation, with warts up to 0.3 µm high.

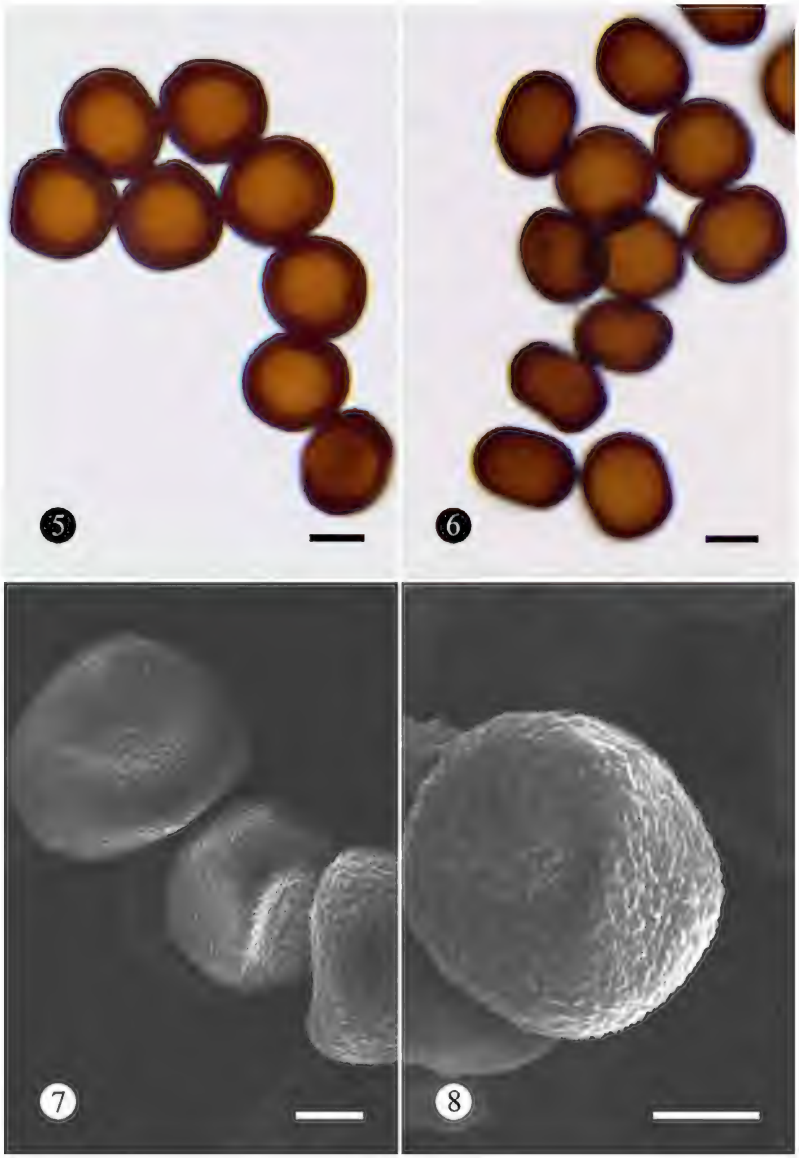
TYPE: on *Carex foenea* Willd.: Canada, Ontario, Constance Bay, 30 June 1938, leg. I.L. Conners (**holotype,** DAOM 18 137).

ETYMOLOGY: the name refers to the host species.

SORI in ovaries, scattered in the inflorescence, as broadly ellipsoidal, ovoid or subglobose, black, hard bodies, 1.7–3.0 mm long, when young covered by a thin membrane, later becoming exposed; spore mass of the mature sori powdery on the surface. SPORES flattened, in plane view broadly elliptical, slightly irregular, suborbicular, orbicular or oval, in plane view 16–22 × 14.5–20.5 [19.0 ± 1.3 × 17.2 ± 1.4] µm (n = 100), in side view 11.5–14 µm thick, middle to dark reddish brown, wall slightly unevenly thickened, 1.3–3.0(–3.5) µm thick, internal swellings, protuberances, and light-refractive spots absent; in LM



Figs 1–4. *Anthracoidea deweyanae* on *Carex deweyana* (DAOM 167 093). Spores in LM and SEM. Scale bars: 1, 2 = 10 µm; 3, 4 = 5 µm.



Figs 5–8. *Anthracoidea foeneae* on *Carex foenea* (DAOM 18 137).
Spores in LM and SEM. Scale bars: 5, 6 = 10 µm; 7, 8 = 5 µm.

verruculose, warts up to 0.3 µm high, spore profile not or slightly affected. Spore germination unknown.

Distribution — On *Cyperaceae: Carex* sect. *Ovales: Carex foenea.*

Comments — *Carex foenea* (sect. *Ovales*) is a North American species distributed from the subarctic to the northern U.S.A. (Mastrogiuseppe et al. 2002). No species of *Anthracoidea* has previously been reported on that sedge. *Carex* sect. *Ovales* is the largest section in *C.* subg. *Vignea,* consisting of about 90 species, predominantly North American, but also with a number of species in mountainous areas of the neotropics and a few species found in North Africa and the temperate zone of Europe and Asia (Egorova 1999, Mastrogiuseppe et al. 2002, Reznicek et al. 2007, Dai et al. 2010).

Four *Anthracoidea* species have been previously described on sedges in section *Ovales: A. fischeri* (P. Karst.) Kukkonen, *A. kanasensis* H.C. Zhang & L. Guo, *A. uleana* (Syd. & P. Syd.) Vánky, and *A. verrucosa* (Savile) Nannf. (Vánky 2011b). *Anthracoidea uleana* differs from *A. foeneae* by a thinner wall (ca 1.0 µm) with 3–4 ring-formed thinner areas while *A. foeneae* has a uniform, up to 3.0(–3.5) µm thick wall. *Anthracoidea fischeri* has spores with echinate ornamentation, with spines up to 1.0 µm high, and a wall with 1–5 internal swellings while *A. foeneae* has verruculose ornamentation with warts ≤0.3 µm high and a wall with no internal swellings. *Anthracoidea verrucosa* is distinguished by its thinner wall (ca 1.0 µm). *Anthracoidea kanasensis* differs from *A. foeneae* by having irregular spores and well developed internal swellings.

Hipp et al. (2006) studied the phylogeny of sedges of section *Ovales* and compared them with representatives of other sections of subgenus *Vignea.* Based on a study of ITS and ETS sequences of those *Carex* species, they marked a sister group to section *Ovales,* which included species of the following sections: *Ammoglochin, Chordorrhizae, Deweyanae, Divisae, Glareosae, Holarrhenae, Phaestoglochin, Physoglochin, Remotae, Stellulatae.* Fourteen species of *Carex* from that sister group are known to be infected by *Anthracoidea* (Table 1).

Table 1. *Anthracoidea* species on sedges from sections closely related to *Ovales.*

Carex section	*Carex* species	*Anthracoidea* species
Ammoglochin	*arenaria*	*arenariae*
	brizoides	*arenariae*
Chordorrhizae	*chordorrhiza*	*aspera, fischeri*
	pseudocuraica	*fischeri*
Deweyanae	*deweyana*	*deweyanae*
Divisae	*duriuscula*	*eleocharidis*
Glareosae	*brunnescens*	*fischeri, karii*
	canescens	*fischeri, karii*
Phaestoglochin	*hoodii*	*verrucosa*
	occidentalis	*vankyi*
Physoglochin	*gynocrates*	*karii, turfosa*
Stellulatae	*echinata*	*karii*
	exilis	*turfosa*
	interior	*fischeri, karii*

All of these nine *Anthracoidea* species differ morphologically from *A. foeneae.*

Anthracoidea savilei Denchev & T. Denchev, **sp. nov.** FIGS 9, 10

MYCOBANK MB 564921

Anthracoidea savilei differs from *A. atratae* and *A. buxbaumii* by smaller spores and unevenly thickened spore walls.

TYPE: on *Carex norvegica* Retz.: Canada, Quebec, Great Whale River, 25 July 1949, leg. D.B.O. Savile, no. 525 (**holotype,** DAOM 28 182).

ETYMOLOGY: named in honour of the Canadian mycologist and botanist D.B.O. Savile (1909–2000).

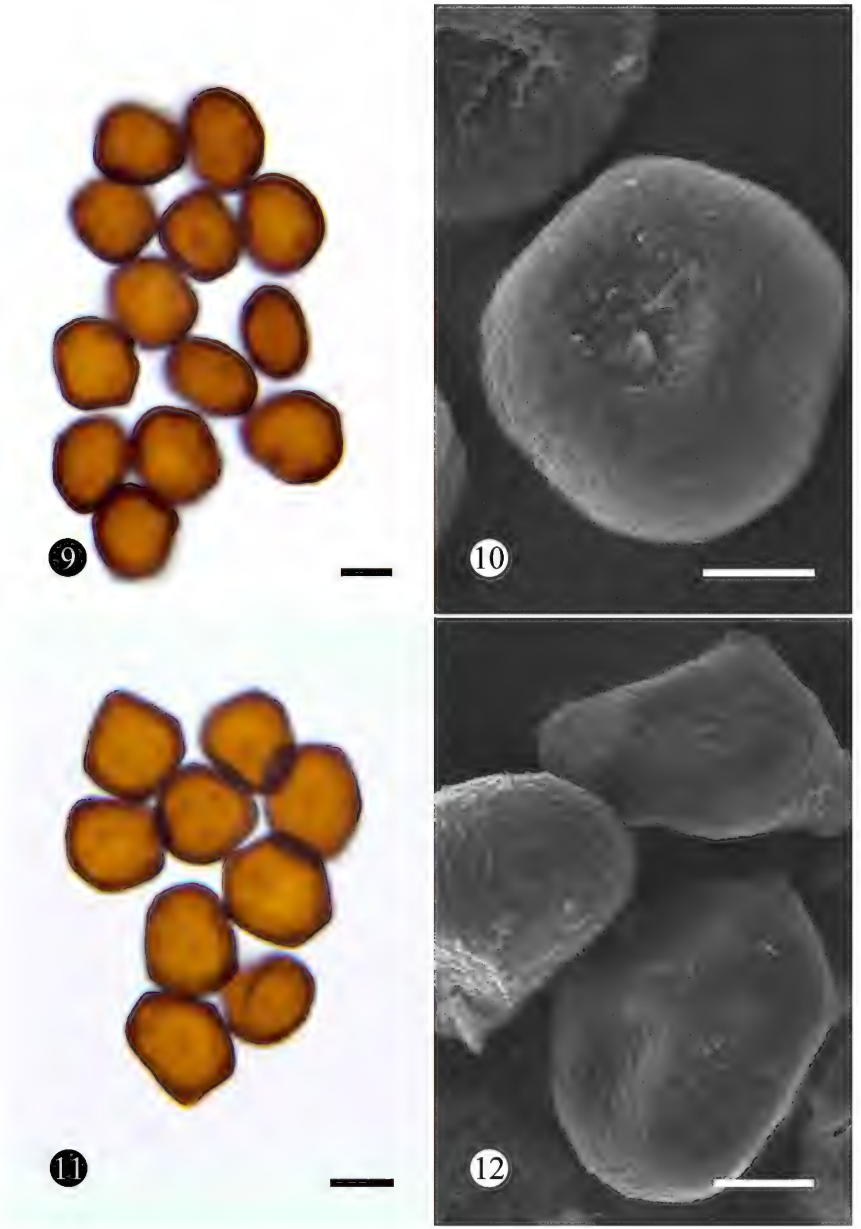
SORI in ovaries, scattered in the inflorescence, as subglobose or broadly ellipsoidal, black, hard bodies, 1.2–1.7 mm long, when young covered by a thin membrane, later becoming exposed; spore mass of the mature sori powdery on the surface. SPORES flattened, in plane view slightly irregular, subpolygonal, broadly elliptical or suborbicular, in plane view (15–)16–21.5 × 12.5–19 [18.5 ± 1.3 × 15.7 ± 1.5] µm (n = 150), in side view 11–13 µm thick, medium reddish brown, wall unevenly thickened, 1.2–2.5 µm thick, thickest at the angles, with 1–3 internal swellings (sometimes conspicuous), occasionally with light-refractive spots; in LM verruculose, warts up to 0.3 µm high, spore profile not or slightly affected; in SEM verruculose, often covered by a gelatinous sheath. SPORE GERMINATION unknown.

DISTRIBUTION — On *Cyperaceae: Carex* sect. *Racemosae: Carex norvegica.*

COMMENTS — *Carex norvegica* is a circumpolar arctic-montane species, distributed in Europe (the northern part and Alps), Asia (Siberia, Far East of Russia, Afghanistan, Mongolia, and the Himalayas), North America (Subarctic to eastern Canada and Montana), and Greenland. It belongs to *C.* sect. *Racemosae* G. Don, a large section within *Carex* with about 62 species in extra-tropical regions of Eurasia and North America (Egorova 1999, Murray 2002a, Dai et al. 2010). This section has commonly been named as *Atratae* (Heuffel) H. Christ (e.g., in Flora Europaea, Chater 1980) in the literature when reporting *Anthracoidea* hosts (e.g., Nannfeldt 1979, Vánky 1994, 2011b). Egorova (1999) displaced the name *Atratae* with *Microrhynchae* Drejer ex L.H. Bailey. Currently, *Racemosae* is recognized as the earliest valid name (Murray 2002a, Dai et al. 2010).

Hendrichs et al. (2004) studied seven species of *C.* sect. *Racemosae* (as *Atratae*), including *Carex atrata* (the type species of the section) and *C. norvegica.* They concluded that the section was homogeneous, and the species studied formed a well supported clade.

The following eight *Carex* species of section *Racemosae* have been previously found to be infected by *Anthracoidea* species: *C. adelostoma* V.I. Krecz. (incl. *C. buxbaumii* subsp. *alpina* (Hartm.) Liro), *C. atrata* L., *C. buxbaumii* Wahlenb., *C. gmelinii* Hook. & Arn., *C. hartmanii* Cajander, *C. heteroneura* S. Watson, *C. raynoldsii* Dewey, and *C. tarumensis* Franch.



Figs 9, 10. *Anthracoidea savilei* on *Carex norvegica* (DAOM 28 182). Spores in LM and SEM.
Figs 11, 12. *Anthracoidea shaanxiensis* on *Carex concinna* (DAOM 223 117).
Spores in LM and SEM. Scale bars: 9, 11 = 10 µm, 10, 12 = 5 µm.

Some sedges in the former section *Atratae* are currently separated in the *C.* sect. *Scitae* Kük. (Egorova 1999, Murray 2002b). The members of that section are morphologically closely related to the species in *C.* sect. *Racemosae.* The following six *Carex* species of *C.* sect. *Scitae* are known as hosts of *Anthracoidea* species: *C. flavocuspis* subsp. *krascheninnikovii* (Kom. ex V.I. Krecz.) T.V. Egorova (≡ *C. krascheninnikovii* Kom. ex V.I. Krecz.), *C. macrochaeta* C.A. Mey., *C. nesophila* Holm, *C. riishirensis* Franch. (incl. *C. koraginensis* Meinsh.), *C. podocarpa* R. Br. (incl. *C. montanensis* L.H. Bailey), and *C. spectabilis* Dewey.

Two *Anthracoidea* species have been previously described on sedges in sections *Racemosae* and *Scitae: A. atratae* (Savile) Kukkonen and *A. buxbaumii* Kukkonen. *Anthracoidea atratae* differs from *A. savilei* by having larger spores (17–25 µm long), evenly thickened walls without internal swellings, and verrucose ornamentation with higher warts (up to 0.7 µm). *Anthracoidea buxbaumii* differs from *A. savilei* by having larger spores (19–28(–30) µm long) and evenly thickened walls.

Nannfeldt (1979: 36–37) referred to five undescribed *Anthracoidea* species on sedges from sect. *Racemosae.* Among them the following ones are noteworthy: "*Anthracoidea* sp. 9" on *Carex norvegica* (based on specimens from Sweden and Finland), "*Anthracoidea* sp. 8" on *Carex holostoma* Drejer (from Canada), and "*Anthracoidea* sp. 10" on *Carex stylosa* C.A. Mey. (from Alaska). The first and second of these possess larger spores than those of *A. savilei,* while the third species is too briefly characterized to be critically compared with other *Anthracoidea* species.

Key to the *Anthracoidea* species on *Carex* sects. *Racemosae* and *Scitae*
(modified after Vánky 2011b)

1	Spores (15–)16–21.5 µm long, wall unevenly thickened, with 1–3 internal swellings (sometimes conspicuous), verruculose, warts ≤0.3 µm high. [Currently known on *C. norvegica.*]	***A. savilei***
1*	Spores larger, wall evenly thickened	**2**
2	Spores 17–25 µm long, internal swellings lacking, verrucose, warts up to 0.7 µm high. [Currently known on *C. atrata, heteroneura, flavocuspis* subsp. *krascheninnikovii, macrochaeta, nesophila, podocarpa, raynoldsii, riishirensis,* and *spectabilis.*]	***A. atratae***
2*	Spores 19–28(–30) µm long, with 1–3 internal swellings, verruculose, warts ≤0.3 µm high. [Currently known on *C. adelostoma, buxbaumii, gmelinii, hartmanii,* and *tarumensis.*]	***A. buxbaumii***

Anthracoidea shaanxiensis L. Guo — Figs 11, 12

Sori in ovaries, scattered in the inflorescence, as subglobose or broadly ellipsoidal, black, hard bodies, ca 1.8 mm long, when young covered by a thin membrane, later becoming exposed; spore mass of the mature sori powdery

on the surface. Spores flattened, in plane view mainly irregular, subpolygonal, sometimes broadly elliptical, in plane view 14–21.5(–23) × 11.5–17.5 [17.0 ± 1.8 × 14.2 ± 1.5] µm (n = 50), in side view 10–12 µm thick, medium reddish brown, wall unevenly thickened, 0.9–2.2 µm thick, occasionally small protuberances present, with 1–3 internal swellings, sometimes light-refractive spots present; in LM verruculose, warts up to 0.3 µm high, spore profile not affected or nearly so. Spore germination unknown.

Specimen examined — On ***Carex concinna*** R. Br.: **CANADA, Northwest Territories,** Nahanni National Park, 61°52' N, 126°37' W, 570 m, 9 July 1976, leg. S. Talbot, no. T 6038-13 (DAOM 223 117).

Distribution — On *Cyperaceae: Carex* sect. *Clandestinae: Carex capilliculmis* S.R. Zhang (≡ *C. filamentosa* K.T. Fu, nom. illegit.), *C. concinna, C. shaanxiensis* F.T. Wang & Tang ex P.C. Li, Asia (China), North America (Canada).

Comments — *Carex concinna* is a North American species, distributed in Canada and U.S.A. It belongs to section *Clandestinae* (= *Carex* sect. *Digitatae*) which includes ca 35 species from Europe, Asia, and North America, mostly from the temperate zone of Asia (Egorova 1999, Crins 2002, Dai et al. 2010).

Six *Anthracoidea* species are reported on members of sect. *Clandestinae: A. caricis* (Pers.) Bref., *A. humilis* Vánky, *A. irregularis* (Liro) Boidol & Poelt, *A. rupestris* Kukkonen, *A. shaanxiensis* (including *A. filamentosae* L. Guo), and *A. striata* H.C. Zhang & L. Guo. The morphology of the specimen examined here matches the description of *A. shaanxiensis,* recorded here for the first time from North America and on a new host plant. Previously, *A. shaanxiensis* has been reported only from Chinese localities: on *Carex shaanxiensis,* from Shaanxi Province, and *C. capilliculmis* (as *C. filamentosa*), from Gansu Province (Guo 2004, 2006).

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Type studies on four *Entoloma* species from South China

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Abstract — The types of *Entoloma caespitosum*, *E. carneobrunneum*, *E. metuloideum*, and *E. pseudogriseoalbum* from South China were studied. *Entoloma carneobrunneum* and *E. caespitosum* are shown to be conspecific, *E. pseudogriseoalbum* is revised based on re-examination of the holotype and additional material, and *E. metuloideum* is referred to *Inocybe* but requires further study to establish its relationships with other species in that genus.

Key words — morphology, revision, taxonomy

Introduction

Entoloma (Fr.) P. Kumm. is very species-rich with over 1000 species reported worldwide (Kirk et al. 2008), yet only 22 species have been described originally from China (Bi et al. 1986, He et al. 2011, 2012, Li & Li 2009, Li et al. 2009, Ying 1995, Zhang & Li 2002a,b, Zhang et al. 1994a,b). Few additional records have been added since their publication, probably because some taxa were described poorly or diagnosed incorrectly. During our recent study of the holotypes and additional material, we discovered that essential taxonomic characters of some type specimens differ considerably from the original published descriptions. Here we describe amended concepts based on our thorough reexamination of four species from South China.

Materials & methods

Morphological descriptions

Type specimens and additional collections of *Entoloma caespitosum*, *E. carneobrunneum*, *E. metuloideum*, and *E. pseudogriseoalbum* were studied. All collections cited are deposited at the Fungal Herbarium of Guangdong Institute of Microbiology (GDGM).

Original Latin descriptions are copied from Zhang et al. (1994a) and Bi et al. (1986), and redescriptions are compiled from the re-examinations by the present authors. Macro-morphological descriptions are based on field notes and examination of voucher specimens. Micro-morphological data were obtained from dried material observed under a light microscope. Basidiospores, basidia, cystidia, and pileipellis were observed in 5% KOH or 1% Congo Red, while KOH-soluble pigments were examined in distilled H_2O. All measurements were made in 5% KOH. In basidiospore descriptions, Q = the length/width ratio of a basidiospore in profile view. Basidiospore dimensions exclude the hilar appendix or apiculus in profile view. Herbarium codes follow Holmgren et al. (1990).

Molecular procedures and phylogenetic analysis

Genomic DNA was extracted from dried specimens by using a modified CTAB procedure of Doyle & Doyle (1987). ITS rDNA was amplified using primers ITS4 and ITS5 (White et al. 1990; Gardes & Bruns 1993). Amplification was performed in 20 µl volumes containing 0.5 µl template DNA, 8.5 µl distilled water, 0.5 µl of each primer and 10 µl PCR mix. The reactions were carried out with 35 cycles by the following conditions: denaturation (95°C, 30 s), annealing (52°C, 30 s), extension (72°C, 1 min), final extension (72°C, 10 min).

The primers used for sequencing were the same as those for amplification. Sequences generated in this study were deposited in GenBank (Table 1).

Table 1. Specimens included in the molecular analysis.

Species	Specimen No.	Geographic origin	Sequence No.
Entoloma abortivum	GDGM 27313	China: Jilin, Changbai Mountain	JQ291565
	HMJAU 1955	China: Jilin, Changbai Mountain	JQ281483
E. caespitosum	GDGM 27564	China: Hainan, Jianfengling National Nature Reserve	JQ281477
[as *E. carneobrunneum*]	GDGM 24026	China: Guangdong, Yangchun	JQ281491
[as *E. carneobrunneum*]	GDGM 24025	China: Guangdong, Yangchun	JQ281490
E. clypeatum	GDGM 28830	China: Beijing, Huairou	JQ281479
E. conferendum	HKAS 48953	China: Sichuan, Daocheng	JQ281484
E. flavidum	GDGM 24473	China: Guangdong, Shenzhen	JQ281481
E. incanum	HKAS 54614	China: Yunnan, Jingdong Ainaoshan	JQ281488
E. luteum	GDGM 27698	China: Hainan, Jianfengling National Nature Reserve	JQ281486
E. mastoideum	GDGM 28820	China: Guangdong, Yangchun	JQ281476
	GDGM 26597	China: Guangdong, Yangchun	JQ291564
E. omiense	GDGM 27563	China: Hainan, Jianfengling National Nature Reserve	JQ281487
	GDGM 27229	China: Jiangxi, Fuzhou	JQ291566
E. petchii	HKAS 56716	China: Yunnan, Baoshan	JQ281485
E. praegracile	GDGM 29251	China: Guangdong, Nanling National Forest Park	JQ281482
*E. sepium**	—	Italy	JF908001
E. stylophorum	GDGM 25736	China: Hainan, Jianfengling National Nature Reserve	JQ281480
*E. versatile**	UBC F16567	Canada	FJ627026
Inocephalus sp.*	—	Argentina	DQ490636
Clitopilus crispus	GDGM 29931	China: Guangdong, Guangzhou	JQ281489
C. prunulus	HKAS 45904	China: Yunnan, Tengchong	JQ281478

* Sequence downloaded from GenBank

Maximum parsimony (MP) was determined using PAUP* version 4.0b10 (Swofford 2003) for phylogenetic analyses. DNA sequences were edited and aligned with Bioedit and manually modified where necessary. *Clitopilus prunulus* and *C. crispus* were included as outgroup. All characters were treated as unordered and equal weighted, gaps were treated as missing data, and bootstrap values were calculated from 1000 replicates.

Taxonomy

Entoloma caespitosum W.M. Zhang, Acta Mycol. Sin. 13: 192, 1994. FIGS 1–2

≡ *Entoloma carneobrunneum* W.M. Zhang, Acta Mycol. Sin. 13: 193, 1994.

Original Latin description of *Entoloma caespitosum*

Pileus 3–5 cm latus, purpureo-ruber vel rubro-brunneus, conicus, convexus vel planus, in centro acuti umbonatus, glaber, carnosus, margine integris et estriato. Contextus pallide purpureo-ruber, ad stipitem circit. 0.5–1 mm, inodorus. Lamellae primo albae, demum pallide roseolae, subconfertae adnatae vel adnexae, inaequales, marginibus integris. Stipes centralis, cylindricus vel clavatus, 3–9 cm longus, 2–6 mm crassus, albus vel subalbus, fistulosus, fragilis, ad basin mycelio albo. Sporae 6–8-angulosae, apiculatae, 7.5–11.5 (–12.8) × 5–7.5 µm, laeves, pallide roseolae, inamyloideae. Basidia clavata, 30–40 × 7–10 µm, 2-spora, hyalina, sterigmatibus 4–6.5 µm longis. Pleurocystidia clavata, ad apicem acuta, 35–46 × 8–10 µm, hyalina, rara. Cheilocystidia cylindrica, 30–38 × 4–5 µm, hyalina, gregaria, numerosa. Trama hymenophoralis parallelis. Eicute [sic] pilei ex hyphis repentibus, hyalinis. Hyphae defibulatae.

Original Latin description of Entoloma carneobrunneum

Pileus 2–4 cm latus, atro-carneo-brunneus, in centro atrobrunneus, siccus, plano-umboatus, glaber, carnosus. Contextus albus, 0.5–1.5 mm crassus, inodorus. Lamellae pallide rosaceae vel carneo-albae, late adnatae vel breviter decurrentes, subdistantes, inaequales, marginibus integris. Stipes centralis, cylindricus vel subclavatus, 2–4 cm longus, 3–5 mm crassus, albus, fistulosus, fibrus, glaber. Sporae (5–)6–7-angulosae, saepe 6-angulosae, apiculatae, 7.7–10 × 5–7.7 µm, laeves, pallide roseolae, inamyloideae, 1–2-guttulatae. Basidia clavata, 26–36 × 9–10 µm, 4-spora, hyalina, sterigmatibus 2.6–3.8 µm longis. Pleurocystidia desunt. Cheilocystidia cylindrica, nonnumquam ad apicem capitata, 40–90 × 4–7 µm, hyalina, numerosa. Trama hymenophoralis parallelis. Epicute pilei ex hyphis repentibus, cylindricis, hyalinis. Hyphae defibulatis.

Revised description

BASIDIOMATA medium-sized. PILEUS 2–5 cm broad, conical to convex at first, expanding to plano-convex, applanate or upturned with a very pronounced, papillate umbo, slightly to distinctly striate almost up to center, dry, not hygrophanous, smooth, with straight and entire to crenulate margin sometimes exceeding gills, pale brown to brown at the umbo, paler elsewhere, carneous white (4B2) to carneous brown (7C3). LAMELLAE adnate-emarginate to adnexed, subventricose, up to 4 mm broad, white at first becoming pinkish with age, moderately crowded, thin, with concolorous and irregular edge, with 3–4 tiers of lamellulae. STIPE central, 30–90 × 2–6 mm, cylindrical, equal, smooth, slightly polished, surface dry, concolorous with or slightly paler than pileus, hollow, brittle, with white tomentum at base. CONTEXT white, thin. ODOR not distinctive, TASTE not known.

Fig. 1. *Entoloma caespitosum* basidiomata.
a. GDGM 24026. b. GDGM 27564.c. GDGM 24025.

Basidiospores 8.5–10.5 × 6–7.5 μm, Q = 1.23–1.54, heterodiametric, relatively thin-walled, 6–9-angled with blunt angles in profile view. Basidia 30–45 × 8–12 μm, clavate, 4-spored, sometimes 2-spored. Lamellar edge sterile. Cheilocystidia in clusters along the lamellar margin, 30–80 × 5–11 μm, cylindrical to narrowly clavate, hyaline, thin-walled. Pleurocystidia absent. Hymenophoral trama parallel, made up of cylindrical elements, 50–110 × 5–16 μm. Pileipellis a cutis, made up of repent hyphae, terminal cells cylindrical to subclavate, 5–12

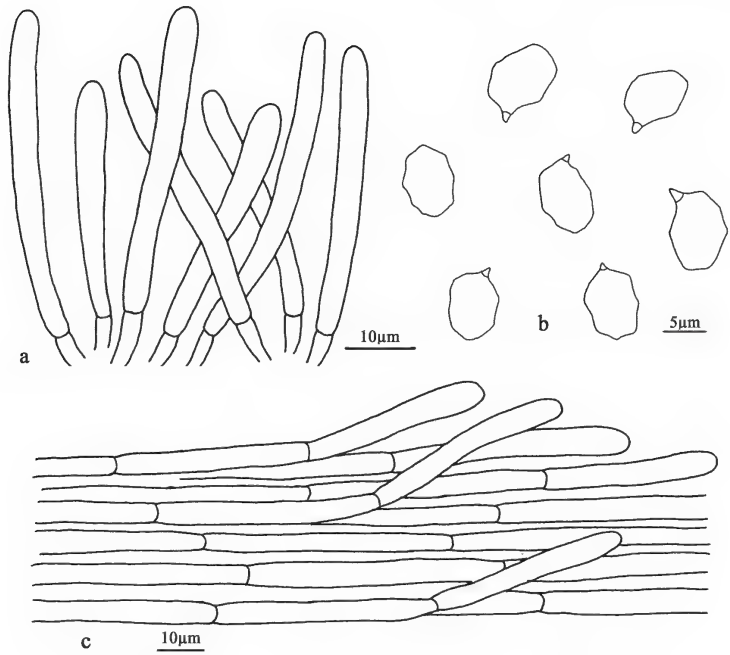

Fig. 2. *Entoloma caespitosum* (GDGM 16476), microscopic structures.
a. Cheilocystidia. b. Basidiospores. c. Pileipellis.

μm wide, with pale yellow brownish, intracellular pigment. Pileitrama regular, consisting of cylindrical hyphae. Stipitipellis a cutis of cylindrical to subclavate hyphae, 3–9 μm in diameter. Brilliant granules very abundant in lamellar trama and pileitrama. Oleiferous hyphae abundant in lamellar trama. Clamp connections absent in all tissues.

Habitat: Scattered to caespitose, on sandy soil of tropical rainforest with *Ficus*, *Castanopsis*, *Machilus*, *Cyclobalanopsis*, and *Taxodiaceae*.

Specimens examined — **China. Hainan Province**: Ledong County, Jianfengling National Forest Park, at 18°36′–52′N 108°40′–109°02′E, alt. 680–730 m, 21 October 1988, Chen Huan-Qiang (GDGM 16476, holotype); 21 August 1988, Chen Huan-Qiang (GDGM 15619); 28 July 2009, Li Tai-Hui & Huang Hao (GDGM 27564); 850–900 m, 11 June 1990, Chen Huan-Qiang (GDGM 16726, holotype of *E. carneobrunneum*); **Guangdong Province**: Zhaoqing, Dinghushan, 21 November 1992, Li Tai-Hui (GDGM 18333, as *E. carneobrunneum*); Yangchun County, Ehuangzhang, Xianjiatong, 26 April 2005, Li Tai-Hui & Wu Li-Min (GDGM 24136, as *E. carneobrunneum*); 26 April 2005, Li Tai-Hui & Wu Li-Min (GDGM 24025, as *E. carneobrunneum*); 26 April 2005, Li Tai-Hui & Wu Li-Min (GDGM 24026, as *E. carneobrunneum*).

Commentary — The caespitose habit, plano-convex or applanate pileus with papillate umbo, 6–9-angled basidiospores with blunt angles, and the abundant cheilocystidia are distinctive for *E. caespitosum*.

The holotype consists of caespitose basidiocarps in good condition, and another collection (GDGM 15619) in GDGM was also cited by Zhang et al. (1994a) in the protologue of *E. caespitosum*. Re-examination of the voucher collections showed that — contrary to the original description — the pileus is umbonate with a striate margin, most basidia have four slender sterigmata, and apically acute clavate pleurocystidia are absent from the hymenium.

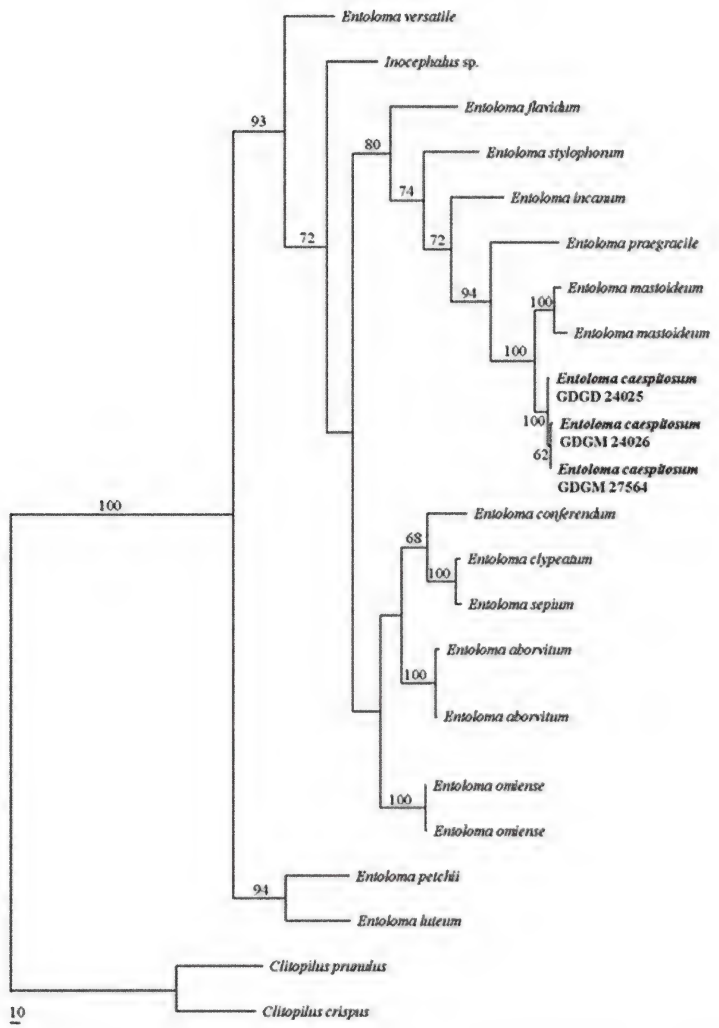

FIG. 3. Phylogeny of *Entoloma caespitosum* and related species, generated by Maximum Parsimony analysis based on ITS sequences. Values above the branches are parsimony bootstraps >50%.

In the same publication, Zhang et al. (1994a) described a later collection from the same area (GDGM 16726) as *E. carneobrunneum*, said to differ from *E. caespitosum* mainly by the absence of pleurocystidia. However, we found no differences between the two holotypes in macro- and microscopic characters. Comparisons of the *E. caespitosum* specimens and four *E. carneobrunneum* collections (GDGM 18333, GDGM 24136, GDGM 24025, and GDGM 24026) revealed no convincing morphological or ITS sequence (Fig. 3) differences between the two taxa. Therefore, we consider *E. carneobrunneum* a synonym of *E. caespitosum*.

A 2009 collection (GDGM 27564) from the *E. caespitosum* type locality provided additional information for this taxon (Fig. 1). It has mostly the same characters (caespitose habit, plano-convex pileus with distinct papillate umbo, thin-walled basidiospores with 6–9 angles in profile view, abundant cheilocystidia forming a sterile edge) as cited in the protologue of *E. caespitosum*, but has a carneous white pileus in the field as shown in the photographs (Fig. 1). As it otherwise shares the same diagnostic characters with *E. caespitosum*, we revise the pileus color to carneous white to carneous brown based on the holotype and the new material. In addition, GDGM 27564, GDGM 24025 and GDGM 24026 cluster together phylogenetically with high statistical support based on rDNA ITS sequence data (Fig. 3). Unfortunately, no DNA sequences were successfully generated from the holotype.

Another scattered to caespitose species, *E. mastoideum* T.H. Li & Xiao Lan He, described recently from South China, shares with *E. caespitosum* a plano-convex to applanate pileus with papillate umbo (He et al. 2011). However, *E. mastoideum* has larger basidiospores (9.5–12(–13) × 7–8(–8.8) µm). Furthermore, the molecular data indicated that the two species are quite different from each other (Fig. 3).

Entoloma metuloideum W.M. Zhang & T.H. Li, Mycosystema 21: 153, 2002. Fig. 4

Original Latin description

Pileus 6.5 cm latus, plano-umbonatus carnosus, pallide purpureo-vitellinus, flavo-brunneus vel atro-brunneus in centro, siccus, humidus, glaber. Contextus flavidus, ad stipitem circit 2 mm, indorus, sapor mitis. Lamellae pallide viridi-flavae, subdistantes, inaequales, marginibus integris, adnate vel breviter decurrentes. Stipes centralis, 6.5 cm longus, 6 mm crassus, vitellinus, cylindricus, ad apicem tenuis, in basi inflatus, villosus, fibrus, solidus. Sporae 6–9.6 × 4.8–7.2 µm, 4–5(–6)-angulosae, polymorphae, pallide roseolae, glabrae, apiculatae. Basidia 19–26 × 6–8 µm, clavata, 4-spora, hyalina, sterigmatibus 2.4 µm longis. Pleurocystidia (metuloidae) 38–62 × 12–17 µm, clavata vel subfusiformia, hyalina, numerosa, apicibus appendicibus granulatis vel globosis praeditis, membranis crassis. Cheilocystidia similia pleurocystidiis (metuloidis) crassitunicatis vel tenuitunicata, 19–24 × 5–7 µm, cylindrica vel subclavata, hyalina, caepitosa [sic], numerosa. Trama hymenophori subparallela, hyphis inflatis et cystoformibus tenuitunicatis hyalinis praedita. Pileipellis ex hyphis 4.8–7.2 µm crassis, repentibus, cylindricis, hyalinis composita. Fibulae praesentes.

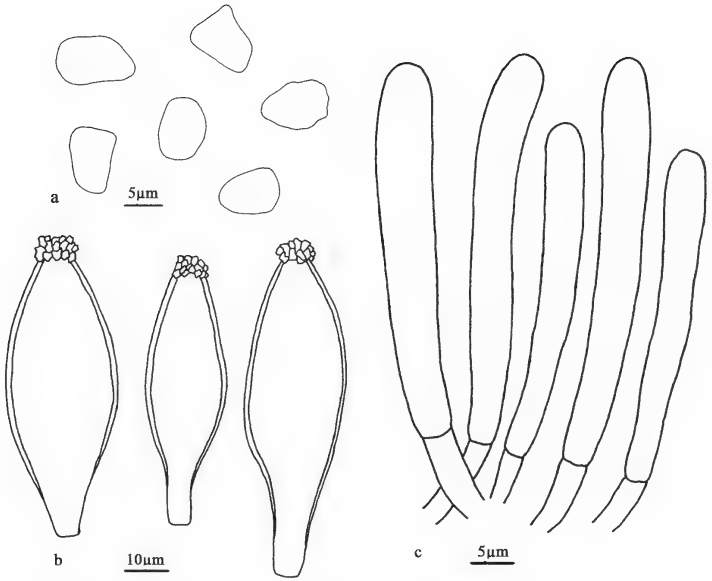

Fig. 4. *Entoloma metuloideum* [= an *Inocybe*] (GDGM 18773), microscopic structures. a. Basidiospores. b. Pleurocystidia. c. Cheilocystidia.

Revised description

Basidioma medium-sized. Pileus to 6.5 cm broad, applanate, umbonate, pale yellowish brown with purple tinge, yellow-brown to brown at the umbo, dry, hygrophanous, glabrous, faintly striate at margin. Lamellae adnate with short decurrent tooth, greenish yellow, moderately distant, moderately thick, up to 8 mm broad, with concolorous and uneven edge, with 2 tiers of lamellulae. Stipe central, 65 × 6 mm, dark yellow with reddish tinge, cylindrical, gradually enlarged towards the inflated base, dry, solid, fibrillose. Context yellowish, 2 mm thick at disk. Odor and taste not distinctive.

Basidiospores 7.5–10 × 6–7.5 μm, 4–5(–6)-angled, polymorphic, without an apiculus, not truly angular, smooth, yellowish brown in KOH. Basidia 19–26 × 6–8 μm, clamped at base, clavate, very pale yellow brown in KOH, 4-spored, sterigmata 2.4 μm in length. Lamellar trama composed of thin-walled hyphae 5–14 μm in width, pale yellow brownish in KOH. Pleurocystidia 58–100 × 15–27 μm, cell walls mostly 0.5–2.5 μm thick, fusiform-ventricose with a short pedicel, colorless, apices obtuse and usually crystalliferous. Cheilocystidia of two types: (1) metuloids similar to pleurocystidia; (2) cylindrical to narrowly clavate, 19–24 × 5–7 μm, in clusters, hyaline, thin-walled. Pileipellis a cutis, consisting of cylindrical hyphae, terminal elements 5–10 μm in diam, cylindrical to clavate. Clamp connections present in pileipellis.

Habitat: Solitary, on soil in deciduous woods.

Specimen examined — **CHINA. Guangdong Province:** Tianjingshan, Nanling National Nature Reserve, alt. 1700 m, 26 October 1995, Zhang Wei-Min (GDGM 18773, holotype).

Commentary — The holotype is in good condition and consists of a robust yellow-brown basidioma provided with field notes. Re-examination of this holotype showed that the pale brown basidiospores are not truly angular as in *Entoloma* species and lack the distinctive prominent apiculus typical of *Entoloma* taxa. The combined features of brownish green lamellae, yellow-brown and not truly angular basidiospores, pale yellow-brown lamellar trama, and distinctive thick-walled metuloid pleurocystidia indicate that this taxon represents *Inocybe* (Fr.) Fr.. Further comparative study is required to establish the specimen's relationship with other *Inocybe* species.

Entoloma pseudogriseoalbum Z.S. Bi, Acta Mycol. Sin. 5: 164, 1986. Fig. 5

Original Latin description

Pileus 6–14 mm latus, primo campanulatus vel convexus, dein planus in centro subumbilicus, siccus, albus vel pallide brunneus, carnosus, in centro tomentosus vel glaber, ad marginem radiate striatus. Contexto albo, tenui, sapor mitis. Lamellae primo albae, demum rosaceae, subdistantes, brever decurrentes, inaequalis. Stipe centralis, albus, 2–4 cm longus, 2–3 mm crassus, cylindricus, fistulosus, fibrus, incrassatus basin versus. Sporae quadrate, 12–13 × 10–12 μm, pallide rosaceae. Basidia 50–60 × 10–12 μm, clavata, 4-spora, subhyalina. Pleurocystidia et cheilocystidia desunt. Trama hymenophoralis parallelis. Epicute pilei ex hyphis evertibus, subhyalinis. Hyphis fibulatis.

Revised description

Basidiomata small. Pileus 6–14 cm broad, convex to campanulate at first, expanding to plano-convex or applanate, with a slightly depressed or subumbilicate center, sometimes with a small and indistinct papillae in the depression, smooth, tomentulose to minutely squamulose in the center, whitish when young becoming pale brownish, radially striate almost to center, dry, not hygrophanous, with straight and entire margin. Lamellae subdecurrent, moderately distant, ≤2 mm broad, white at first becoming pinkish with age, thin, with concolorous and irregular edge, with 2 tiers of lamellulae. Stipe central, 20–50 × 1–2 mm, cylindrical, equal, hollow, innately fibrillose, dry, with white tomentum at base. Context white, thin. Odor not distinctive, taste mild.

Basidiospores 7.0–9.0 μm, cuboid or quadrate in profile view, relatively thin-walled. Basidia 34–47 × 10–12 μm, clavate, 4-spored, with sterigmata of 4–5 μm in length, without clamp-connections at base. Lamellar edge sterile. Cheilocystidia in clusters along the lamellar margin, cylindrical to narrowly clavate, 50–110 × 6–10 μm, hyaline, thin-walled. Pleurocystidia absent. Hymenophoral trama parallel, made up of cylindrical elements. Pileipellis a cutis with a transition to a trichoderm, terminal cells cylindrical to subclavate, 7–12 μm wide, with pale yellow brownish, intracellular pigment.

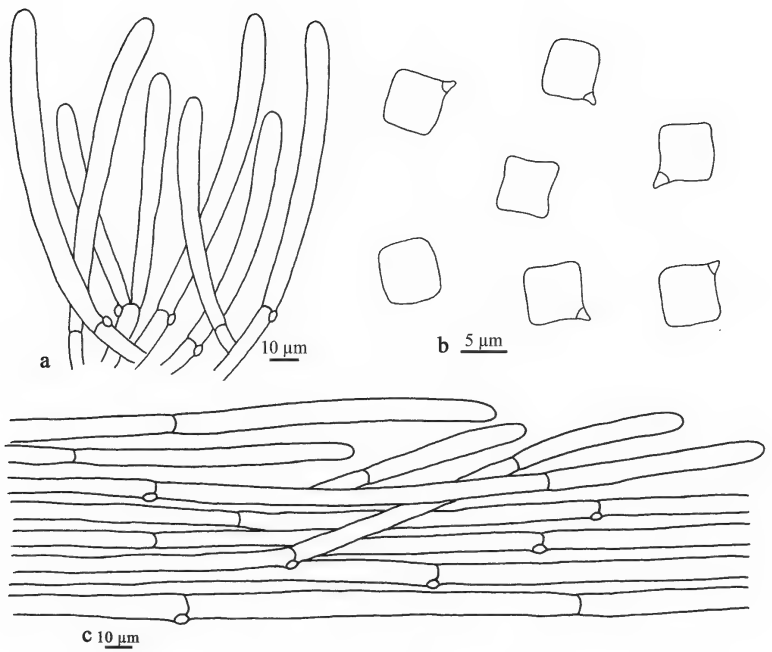

Fig. 5. *Entoloma pseudogriseoalbum* (GDGM 7457), microscopic structures. a. Cheilocystidia. b. Basidiospores. c. Pileipellis.

Pileitrama regular of cylindrical hyphae. Stipitipellis a cutis of narrow and cylindric hyphae, 3–9 μm in diameter. Caulocystidia absent. Brilliant granules absent. Oleiferous hyphae rare. Clamp connections present in all tissues.

Habitat: Scattered or solitary, on soil in deciduous woods.

Specimens examined — **China. Guangdong Province:** Yangshan County, 1 September 1984, Li Tai-Hui & Zheng Guo-Yang (GDGM 7457, holotype); Heyuan, 13 September 2001, Li Tai-Hui (GDGM 20485); Yangchun County, 18 August 2004, Li Tai-Hui (GDGM 21738).

Commentary — *Entoloma pseudogriseoalbum* is characterized by the umbilicate pileus, cuboid basidiospores and abundant cylindrical cheilocystidia.

In the original protologue, the basidiospores were described as 12–13 × 10–12 μm, and cheilocystidia were absent (Bi et al. 1986). However, the basidiospores of the type collection are less than 10 μm in size, and the cheilocystidia are abundant, forming a sterile band on the lamellar edge. Two collections collected from Heyuan (GDGM 20485) and Yangchun (GDGM 21738) not far from the type locality are identical with the holotype of *E. pseudogriseoalbum*.

Entoloma talisporum Corner & E. Horak, originally described from Papua New Guinea, resembles *E. pseudogriseoalbum* in its small basidiomata, subumbilicate whitish pileus, subdecurrent lamellae, and cuboid basidiospores, but differs in its smaller basidiospores (6–8 μm) and absence of cheilocystidia (Horak 1976).

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Notes on *Stereocaulon* species from Bolivia

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Abstract — *Stereocaulon crambidiocephalum*, *S. pachycephalum*, and *S. pomiferum* are reported as new to Bolivia. Notes on the recently discovered holotype of *S. meyeri* are included.

Key words — lichenized fungi, lichen metabolites, Neotropics, taxonomy

Introduction

The genus *Stereocaulon* Hoffm. (*Stereocaulaceae*, *Lecanorales*, lichenized *Ascomycota*) is represented by about 29 species in the Neotropics (Lamb 1977, 1978, Boekhout 1982, Sipman 1986, Weber 1986, Marcano et al. 1995, Sipman 2002). Although some neotropical countries are reasonably well studied, many, including Bolivia, have been only partially explored. However, the investigation of the lichen flora of Bolivia in recent years has made considerable progress (e.g. Flakus & Wilk 2006, Flakus 2008, Flakus & Lücking 2008, Flakus et al. 2008, 2011, 2012; Knudsen & Flakus 2009, Kukwa & Flakus 2009, Flakus & Kukwa 2012, Knudsen et al. 2012) and, among many others, several collections of *Stereocaulon* have become available. According to Rodriguez et al. (2012), 13 *Stereocaulon* species (four with intraspecific taxa) have been reported from Bolivia; some of these are known only from old records, which should be revised.

After an examination of the recently collected material and relevant literature, it appeared that three species have not been previously reported from Bolivia. In case of *S. meyeri*, a taxon already known from the country, notes of the recently discovered holotype are provided. This paper provides information on these taxa, thereby expanding our knowledge of lichen diversity in Bolivia and of *Stereocaulon* in particular.

Material & methods

Material from KRAM, LPB, and UGDA was studied and compared with specimens deposited in BM, H, H-ACH, H-NYL, LOD, UPS, and WRSL. Morphological characters (i.e. thickness, morphology and colour of thallus; shape of phyllocladia; presence, shape and size of cephalodia) were examined using a stereomicroscope. Cyanobacteria in cephalodia were examined under a light microscope and determined to the genus level. Chemical analyses were performed by thin-layer chromatography (TLC) in solvents A and C according to the methods of Culberson & Kristinsson (1970) and Orange et al. (2001). The descriptions and chemical compounds presented below are based on our own observations.

Most authors (e.g. Lamb 1977, 1978, Boekhout 1982, Sipman 2002) use the term phyllocladia for all types of thalline outgrowths present on pseudopodetia; however, if they are coralloid, the term phyllocladial (or pseudopodetial) branchlets should be applied (see Lamb 1951, 1978, Boekhout 1982)

The taxa

Stereocaulon crambidiocephalum I.M. Lamb, J. Hattori Bot. Lab. 43: 290. 1977.

Morphology — Primary thallus persistent. Pseudopodetia 4–5 cm tall, erect, coarse, not or little branched at the base, attenuated towards the apex, decorticated. Phyllocladial branchlets present only on the lower part of the pseudopodetia, coralloid. Cephalodia sacculate, concolorous with the pseudopodetia to grey, containing *Rhizonema* (previously referred to as *Scytonema*; see Lücking et al. 2009). Soralia present, capitate, developing on minute congested corymbose branchlets, terminal on the pseudopodetia.

Chemistry — Atranorin and perlatolic acid (in accordance with Lamb 1977).

Distribution and habitat — *Stereocaulon crambidiocephalum* is a rare species, known only from the Neotropics in Colombia, Costa Rica, Peru, and Venezuela (Lamb 1977, Boekhout 1982, Sipman 1992, Umaña-Tenorio et al. 2002, Sipman et al. 2008). In this paper we report the first localities from Bolivia, where it was found on rocks at 3800–4100 m altitudes in open habitats.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Inquisivi, Barrancos de Sayaquita, cliffs north of the road between Pongo and Sayaquita, c. 1 km E of Sayaquita, 67°16′W 17°00′S, c. 3800 m, 09.07.1986, Lewis 66-172 (LPB); Prov. Murillo, near Cumbre Pass, 16°19′18″S 68°04′42″W, 4550 m, high Andean Puna vegetation, 17.06.2006, Flakus 8522,1 (KRAM, LPB); Prov. Tamayo, Comunidad Klara (nueva), desde el pueblo cruzando el Río Jatun Kuchu, subiendo la ladera en dirección norte, 14°41′S 69°05′W, 4100 m, 17.06.2005, Jimenez, Fuentes 2772 (LPB).

Notes — *Stereocaulon crambidiocephalum* resembles *S. meyeri* in chemistry and morphology but can be distinguished by its large apical heads of soredia borne on fine congested branchlets; in *S. meyeri* soredia develop directly on the main pseudopodetial branches (Lamb 1977, 1978) and do not form apical heads.

Stereocaulon meyeri Stein, Jahresber. Schles. Ges. Vaterl. Cult. 66: 134. 1888.

Type: Tanzania, Mt. Kilimanjaro, altit. 4000 m, 01.09.1887, Meyer (WRSL! – holotype).

Morphology — Primary thallus disappearing. Pseudopodetia up to 7 cm tall, erect or creeping with ascending tips, not or little branched at the base, towards the apex attenuated, glabrous or tomentose, pale ochraceous to greyish. Phyllocladial branchlets present sometimes only on the upper side of the pseudopodetia, coralloid or tending to palmate, greyish-green. Cephalodia sacculate, pale to ash grey, containing *Rhizonema* (previously referred to as *Scytonema*; see Lücking et al. 2009). Soralia present, terminal on the pseudopodetia, finely granular.

Chemistry — Atranorin and perlatolic acid (in accordance with Lamb 1977).

Distribution and habitat — The distribution of *S. meyeri* is restricted to the Neotropics, southern South America, and Africa (Lamb 1977). In the Neotropics, it has been reported previously from Bolivia (but only from a single locality), Peru, Ecuador, Colombia, Venezuela, and Mexico (Lamb 1977, Boekhout 1982, Feuerer et al. 1998, Sipman et al. 2008). In Bolivia the species was found on rocks in high mountains from 3700 m upwards.

Additional specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Murillo, Cordillera Real, Valle de Zongo, Laguna Viscachani, 3800 m, orilla de la laguna, zona de rocas grandes, vegetación tipo Puna, 27.08.1988, Stab LB 157 (LPB); Rio Minasa, area of Rio Minasa at river forks in Villa Urkupiña, c. 1.5 km N of the old rail road bridge in Villa Condoriri, c. 5 km E of N from Plana San Francisco (La Paz), 16°27′S 68°08′W, c. 3980 m, semi-humid grasslands with *Polylepis*, 1987, Lewis 87-024 (LPB); Prov. Inquisivi, Molinos, near the mouth of the Rio "Pusi Khota" c. 1 km down river from Sayaquita, 1 km S of Estancia Villa El Carmen, 67°16′S 17°00′W, c. 3700 m, 08.07.1986, Lewis 86-120 (LPB).

Notes — Lamb (1977) examined only one specimen sent by B. Stein to Th. Fries (in UPS) and referred to as isotype in his paper. The original specimen was supposed by Lamb (1977) to be preserved in WRSL (as BRSL in his paper), where it has recently been found. We propose here to treat the specimen in WRSL as holotype, because H. Meyer most probably collected only one specimen in Tanzania, which was later divided by Stein, who sent a part to Fries. Lamb (1977) correctly regarded the UPS sample as isotype.

Stereocaulon meyeri is morphologically similar to *S. crambidiocephalum* and *S. ramulosum* (Sw.) Raeusch. (See under *S. crambidiocephalum* for comparison with that species.) The only difference between *S. meyeri* and *S. ramulosum* is the production of soralia, present in the former but absent in the latter (Lamb 1977). Whether *S. meyeri* represents only a sorediate form of *S. ramulosum* should be determined by molecular analysis.

Stereocaulon pachycephalum Vain., Dansk Bot. Ark. 4(11): 7. 1926.

Morphology — Primary thallus disappearing. Pseudopodetia to 6 cm tall, not branched at the base or with a few erect branches, with short branchlets in the upper part, sometimes dichotomously branched, when young corticated, when mature decorticated at the base, medially in different stages of decortication, and in the upper part corticated, greenish-grey. Phyllocladial branchlets present, coralloid or slightly palmate, with a surface made uneven by furrows, with pseudosoredial granules, greenish-grey, sometimes with a pale underside. Cephalodia sacculate, clavate to globose, sometimes flattened, pale to dirty grey, containing *Rhizonema* (previously referred to as *Scytonema*; see Lücking et al. 2009). Apothecia of lecideine appearance, terminal on the pseudopodetia.

Chemistry — Atranorin, fumarprotocetraric and perlatolic acids (in accordance with Lamb 1977, deficient phase II).

Distribution and habitat — This species is restricted to the Neotropics from Ecuador, Colombia, Venezuela, Peru, and Mexico (Lamb 1977, Boekhout 1982, Sipman 1992, Sipman et al. 2008). We report it here for the first time from Bolivia, where it was found on the ground at a 3050–3810 m altitude.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Nor Yungas, Cotapata, 16°17′S, 67°51′W, 3050 m, bosque altomontano, alterado, s.coll. (LPB); 20 km from Sorata on road to Achacachi, steep road bank, 3450 m, terrestrial, 10.12.1980, Balslev 1096 (LPB); Prov. Murillo, Valle de Zongo, 3810 m, terreno cespitoso rocoso con algunos arbustos cerca de Laguna Viscachani, 12.01.1980, Beck 2822 (LPB); La Paz, 20 km from Sorata on road to Achacachi, steep road bank, 3450 m, terrestrial, 10.12.1980, Balslev 1096 (LPB). **MEXICO. Oaxaca.** El Pelado, Sierra de Oajaca, 2700–3000 m, 09.1842, F. Liebman 71b (UPS L-82699 – isolectotype).

Notes — *Stereocaulon pachycephalum* is chemically variable; the full chemistry includes atranorin, and fumarprotocetraric, lecanoric, perlatolic, sublimbatic and bourgeanic acids. According to Lamb (1977), when perlatolic acid is lacking, the material, represents the so-called 'deficient phase I'; if lecanoric, sublimbatic and bourgeanic acids are not present, it belongs to 'deficient phase II'. All Bolivian specimens are 'deficient phase II'.

When lecanoric acid is present, *S. pachycephalum* is very easily determined, as this substance is not recorded from any other *Stereocaulon* species. Samples lacking this metabolite can be mistaken in South America for *S. novogranatense* I.M. Lamb; however, these taxa are easily separated by the cephalodia, which are cristate (composed of flattened, plate-like segments) in *S. novogranatense* and clavate to globose and sometimes flattened in *S. pachycephalum* (Lamb 1977, 1978).

Morphologically, *S. pachycephalum* is very similar to *S. ramulosum*, but it differs mainly in its chemistry (fumarprotocetraric, lecanoric, sublimbatic, and bourgeanic acids are lacking in *S. ramulosum*), and its longer, more septate

ascospores (45–90 × 2.1–4.6 µm with 4–11 septa, compared with 23–60 × 2.3–4.5 µm with 2–5(–8) septa in *S. ramulosum*) (Boekhout 1982).

Stereocaulon pomiferum P.A. Duvign., Lejeunia Mém.14: 119. 1956.

Morphology — Primary thallus disappearing. Pseudopodetia to 7 cm tall, not branched at the base or with few erect branches, with short branchlets in the upper part, when young corticated, finally at the base decorticated, medially in different stages of decortication and in the upper part corticated, greenish-grey. Phyllocladial branchlets present, coralloid. Cephalodia protosacculate, containing *Nostoc*. Apothecia developed on knob-like receptacles on corymbose branches arising from the upper part of the pseudopodetia.

Chemistry — Atranorin, stictic and norstictic acids (in accordance with Lamb 1977, strain I).

Distribution and habitat — The species is widespread in tropical mountains in central Africa (e.g. Kenya, Uganda, Zaire), Asia (e.g. China, India, Japan, Nepal), and South America (Colombia, Mexico, Peru, Venezuela) (e.g. Lamb 1977, Boekhout 1982, Sipman 1992, Sipman et al. 2008). In this paper it is reported for the first time from Bolivia where it was found on exposed rocks at altitudes of 2200 to 3200 m.

Specimens examined — **BOLIVIA. Dept. Cochabamba.** Prov. Chaperé, Parque Nacional Carrasco, 130 km del camino antiguo de Cochabamba a Villa Tunari, 17°07′S 65°36′W, 2200 m, bosque humedo, saxicola, 10.10.1997, Bach 684 et al. (LPB); cerca de la represa de Corani, 3250 m, muro cerca Candelaria, roca, 27.09.1988, Arrázola (LPB). **Dept. La Paz.** Prov. Murillo, Cordillera Real, Valle de Zongo, Laguna Viscachani, 3810 m, terreno cespitoso rocoso con algunos arbustos cerca de Laguna Viscachani, 12.01.1980, Beck 2822 (LPB).

Notes — *Stereocaulon pomiferum* is chemically variable; four chemotypes can be distinguished (atranorin always present; the nomenclature of chemical strains and deficient phases follows Lamb 1977): (I) with stictic and norstictic acids, sometimes with porphyrillic acid (strain I), (II) with porphyrillic acid alone (deficient phase I of strain I), (III) with unidentified pigments (deficient phase II of strain I) or (IV) with norstictic acid without stictic acid (strain II). All Bolivian specimens belong to chemotype I.

Stereocaulon pomiferum is similar to *S. claviceps* Th. Fr.; they can be readily distinguished as *S. claviceps* produces effuse soredia on branch-apices, while *S. pomiferum* is esorediate (Lamb 1977, 1978).

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Taxonomy and phylogenetic placement of the downy mildew *Peronospora saturejae-hortensis*

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Abstract — Downy mildew of summer savory (*Satureja hortensis*), which causes a potentially devastating disease, has been sporadically observed in Germany since 1913. After severe outbreaks in German summer savory fields in 2004, 2006, and 2009, questions arose about the identity of the downy mildew that is the causal agent of the disease since recent research has suggested that many species of *Peronosporaceae* are narrowly host specific and the application of broad species concepts is inappropriate. ITS rDNA sequence-based phylogenies support this pathogen as a distinct species in *Peronospora* closely related to *P. belbahrii* and *P. salviae-officinalis*, recently described from lamiaceous hosts. A careful comparison with downy mildew species described from *Satureja hortensis* and allied *Lamiaceae* resulted in the identification of the etiological agent of downy mildew of summer savory as *P. saturejae-hortensis*, confirmed by a re-examination of topotype material. A pathogenicity test has confirmed the pathogenicity of *P. saturejae-hortensis* on summer savory.

Key words — *Peronosporales*, morphology, nucleotide sequence

Introduction

In July 2004, typical downy mildew symptoms were observed in an experimental field with different accessions of summer savory (*Satureja hortensis* L., *Lamiaceae*) in the region of Aschersleben (Federal State of Saxony-Anhalt, Germany). On infected leaves, initially pale green spots appeared on the upper surface (Fig. 2), and a light brown to gray covering of conidia appeared on the lower surface (Fig. 3). Later, the affected leaves turned purple-red, became necrotic, and died. Economically relevant yield losses could only be avoided by

an earlier harvest. Another experimental field with the same accessions located in Quedlinburg, a distance of only ca. 40 km, remained healthy. The disease occurred at both locations in 2006 and 2009, but no infections were observed in 2007 and 2008.

Downy mildew on *Satureja hortensis* has been sporadically observed in Germany since 1913 (Feurich 1940, Brandenburger & Hagedorn 2006). The first documented collection was made in Saxony and distributed as *Peronospora lamii* f. *saturejae* Feurich, in Krieger, Fungi saxonici exsiccati 2281. Other German records from Berlin, Rheinland-Pfalz, and Thuringia (Kröber et al. 1971, Brümmer 1990, Brandenburger & Hagedorn 2006) have been attributed to *P. lamii* A. Braun. Due to application of a morphologically based broad species concept, numerous *Peronospora* collections on various hosts of the *Lamiaceae* were previously referred to *P. lamii* (e.g., Francis 1981, Gamliel & Yarden 1998, Minuto et al. 1999, Heller & Barofio 2003, Liberato et al. 2006, Humphreys-Jones et al. 2008, Mielke & Schöber-Butin 2007). Vanev et al. (1993) assigned Bulgarian collections on *Satureja hortensis* to *P. calaminthae* Fuckel, which Mazelaitis & Stanevičienė (1995) also used for a Lithuanian collection on summer savory. Two downy mildews have been described originally from *Satureja* spp., *Peronospora saturejae-hortensis* Osipian (Osipyan 1968) and *Plasmopara satureiae* F.L. Tai & C.T. Wei (Tai & Wei 1933). No recent studies of the biology, morphology, and taxonomy of these two species are available. Therefore, the morphology of the German *Satureja* downy mildew was carefully compared with the relevant species, and the phylogenetic affinities and potential distinctness of the downy mildew were explored through ITS rDNA sequence analysis. Inoculation experiments were completed in order to confirm the pathogenicity of the down mildew on summer savory.

Materials & methods

Morphology: Conidiophores and conidia of the downy mildew were scraped from the leaf surface using a common razor blade, mounted in distilled water, and examined through standard light microscopy using oil immersion (bright field and phase contrast). For each, thirty measurements were made of conidia at 1000× and of conidiophores at 40×, with extremes given in parentheses. The examined collections were deposited in the herbaria HAL, LE and UPS (abbreviations according to Holmgren et al. 1990).

Molecular sequence analysis: DNA was isolated from the strain Psh/QLB1-09 (internal designation) and the partial 18S, ITS1, 5.8S, ITS2 and partial 28S regions were amplified in a single run using primers NS7a and NL4a (5′-AAGTTTGAGGCAATAACAGG-3′ and 5′-TCCTTGGTCCGTGTTTCAAG-3′), and then bidirectionally sequenced on a LI-COR 4000L DNA sequencer with multiple internal primer sites. The sequence was deposited in GenBank under accession no. JN882274 and compared with related GenBank sequences using the neighbour joining algorithm (Kimura two-parameter model with insertions separately accounted for; bootstrap analyses with 1000 replicates) with TreeCon vers. 1.3b (Van de Peer & De Wachter 1994). The alignment was made

with GeneDoc version 2.6. Although significant parts of the 18S and 28S rRNA were sequenced for JN882274, these could not be included in the analysis due to a lack of usable homologous sequences in GenBank. Furthermore, 33 ambiguous base pair positions were excluded.

Pathogenicity test: Plant samples from a field experiment strongly affected by downy mildew were used as starting material for a pathogenicity test with the cv. 'Aromata'. The samples were frozen immediately after collecting and stored at –20 °C for about 9 weeks until plants were available for inoculation. The plants were cultivated in pots with soil, first in a greenhouse at 20–23 °C for about eight weeks and subsequently in a climate chamber at 15–18 °C for one week. The inoculum of about 10^6 conidia/ml was prepared by stirring 150 g infected plant material in 400 ml tap water with the addition of 30 µl Tween 20 (Sigma-Aldrich). Inoculation was carried out in a climate chamber by submerging 48 plants in the inoculum solution and 6 plants in tap water (controls). To achieve a high relative humidity (98–100%), the plants were covered permanently with a plastic tunnel row cover starting immediately after inoculation. The plants were incubated at a temperature of 15 °C on day (16 h at a luminous intensity of 1000 foot candle) and 10 °C at the night (8 h). Morphological observations were made of the downy mildew used for inoculum and of any inoculated plants displaying signs to confirm that the same pathogen was present.

Results

Molecular sequence analyses

Peronospora saturejae-hortensis clusters as a distinct species in *Peronospora* adjacent to other *Peronospora* species on hosts of the *Lamiaceae* with *P. belbahrii* Thines on *Ocimum basilicum* L. (Thines et al. 2009), *P. elsholtziae* T.R. Liu & C.K. Pai on *Elsholtzia ciliata* (Thunb.) Hyl. [= *E. patrinii* (Lepech.) Garcke] (Liu & Pai 1985), *P. salviae-officinalis* Y.J. Choi et al. on *Salvia officinalis* L., and *P. salviae-plebeiae* Y.J. Choi et al. on *Salvia plebeia* R. Br. (Choi et al. 2009) as closest relatives (Fig. 1), but more distant from *P. lamii*, a name previously applied to the summer savory *Peronospora*.

Pathogenicity test

The plants were observed daily, and the first visible symptoms appeared on Day 7 post-inoculation (dpi) as diffuse pale spots on the upper surface of an individual leaf. On the Day 11 dpi, a dense covering of conidiophores carrying masses of visually intact conidia was present on the upper and lower leaf surfaces. One half of the plants was directly harvested and frozen for later use as infection material in subsequent experiments, and the other half was incubated for a further three days. After this time, most leaves showed large necrotic spots and were drooped or already dead. Nearly all (ca. 90%) conidia were collapsed. Microscopic examination of the inoculum and the downy mildew on inoculated plants confirmed that the material represented the same oomycete and was consistent with *P. saturejae-hortensis*. The controls remained symptomless during the observation period.

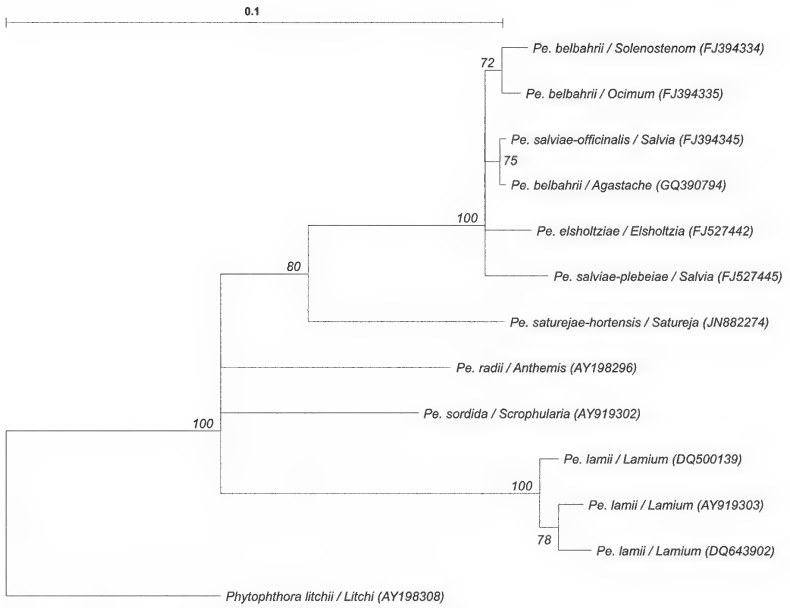

Fig. 1. Neighbour joining cladogram resulting from analysis of the ITS1, 2 and 5.8S rRNA sequence region, (33 ambiguous alignment positions excluded) of strain Psh/QLB1-09 (GenBank JN882274) compared with similar sequences derived from GenBank. For each sequence the species name, host genus, and GenBank accession number are shown. Bootstrap support percent values >70% are indicated on branches (1000 bootstrap replications). "*Pe.*" = *Peronospora*.

Morphology and taxonomy

German collections of the pathogen on *Satureja hortensis* have been studied in detail, based on fresh as well as herbarium material (now deposited at HAL, No. 2409 F, and UPS). In addition, the first German *Peronospora* specimen on summer savory has been re-examined: on *Satureja hortensis*, Saxony, Göda, garden, 15 May 1913, G. Feurich, Krieger, Fungi saxonici exsiccate 2281 (HAL). It is characterised as follows (Figs 2–4):

Colonies hypophyllous, effuse, in irregular patches or confluent, covering the entire lower leaf surface, loosely to densely floccose, light brown; conidiophores emerging through stomata, erect, about (180–)200–400(–410) µm long, hyaline or with a very pale olivaceous tinge, straight or almost so below with tiers of branches at apex, attenuated at the very base and slightly inflated just above the base, 6–11 µm wide, wall up to 2 µm thick, smooth, callose plugs occasionally present in lower unbranched part, rarely in the branched part, apical part branched in acute to right angles (about 25–50%), usually in 4–6 tiers, arborescent, lower portion of the branched part monopodial, upper

FIG. 2. *Peronospora saturejae-hortensis* symptoms on summer savory.
Scale bar = 1 cm.

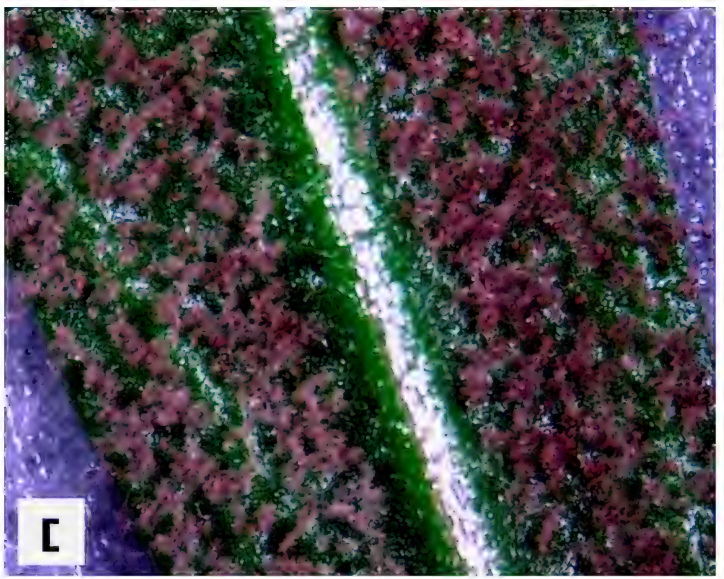

FIG. 3. *Peronospora saturejae-hortensis.*
Colonies on the lower surface of a summer savory leaf. Scale bar = 1 mm.

FIG. 4. *Peronospora saturejae-hortensis*. Conidiophore with conidia. Scale bar = 20 µm.

part monopodial to dichotomous, branches straight to curved, 3–7 µm wide, ultimate branchlets attenuated (conical), 3–23 × 1–3 µm, straight to often curved, tips subacute, obtuse to obconically truncate; conidia broadly ellipsoid (to subglobose), (15–)16–25(–26) × (9–)10–18(–19) µm, length/width ratio 1.1–1.8, pale brown, content granular, wall thin, about 0.5 µm, smooth to faintly rough-walled, scars inconspicuous; resting organs (oospores) not observed.

Osipyan (1968) first described *P. saturejae-hortensis* as follows:

> "Conidiophores up to 580 µm long, 10–12 µm wide, 4–6 times branched, conidia 14.5–18 × 12–15 µm [holotype: on *Satureja hortensis*, Armenia, Etsmiadsin District, Gucasavan, 20 Oct. 1963, L.L. Osipyan (ERCB), not seen]."

A copy of the original description was published in Novotel'nova & Pystina (1985). Topotypical material [wrongly marked as "isotype", see also Constantinescu

(1991)] is deposited in LE [from the type locality, but dated "27 May 1965" (LE 43424); recently re-examined by V.A. Mel'nik, St. Petersburg]. In the topotype, V.A. Mel'nik (in litt.) found conidiophores up to about 400 µm long and conidia 15–23 × 15–18 µm [i.e., a larger morphological variability for conidia than is cited in Osipyan's (1968) original description]. The topotype is a relatively scanty collection. The smaller conidial size given in the original *P. saturejae-hortensis* description suggests that the author did not examine fresh, fully developed material but rather a scanty sample of old material collected late in the season. Alternatively, it is possible that his original description was based on measurements of shrivelled conidia from herbarium material. Overall, we feel these discrepancies are not taxonomically significant.

Discussion

The morphology of the German downy mildew collections on *Satureja hortensis* fully agrees with *Peronospora saturejae-hortensis*, except for conidia that are larger than in the original description (Osipyan 1968). However, the present measurements made from fresh as well as herbarium collections cover the whole range, including the conidial widths. Besides, V.A. Mel'nik's re-examination of the topotype revealed a larger conidiophore and conidial size variability in *P. saturejae-hortensis*. The downy mildew specialist, O. Constantinescu (Uppsala, Sweden, recently deceased), examined a duplicate of the German material now deposited at UPS and confirmed this identification. Due to obvious morphological differences, *Plasmopara satureiae*, the second downy mildew on summer savory, can be clearly ruled out. Type material of this species was not available for re-examination, but according to the original description it differs from *P. saturejae-hortensis* in having much larger (23–38 × 17–29 µm) and papillate zoosporocysts ["sporangia"] (Tai & Wei 1933). Vanev et al. (1993) and Mazelaitis & Stanevičienė (1995) assigned collections on *Satureja hortensis* to *P. calaminthae*. Molecular sequence analyses are not yet available for *P. calaminthae,* which is, however, morphologically distinct and confined to *Clinopodium acinos* (L.) Kuntze [≡ *Calamintha acinos* (L.) Clairv., *Satureja acinos* (L.) Scheele, = *Acinos arvensis* (Lam.) Dandy] and *Clinopodium graveolens* subsp. *rotundifolium* (Pers.) Govaerts [≡ *Acinos rotundifolius* Pers., *Calamintha rotundifolia* (Pers.) Benth., *Satureja rotundifolia* (Pers.) Briq.] (Kochman & Majewski 1970, Novotel'nova & Pystina 1985). These determinations and taxonomic treatments were probably influenced by previous classification of the two *Acinos* taxa in *Satureja*. *Peronospora calaminthae* differs from the summer savory downy mildew in forming grayish violet hypophyllous colonies. Furthermore, the tips of ultimate branchlets are usually subacute and the conidia are broader, about 15–22 µm (Gäumann 1923, Kochman & Majewski 1970, Novotel'nova & Pystina 1985).

Molecular sequence analyses support placement of the *Satureja hortensis* downy mildew in *Peronospora* as a phylogenetically distinct species. This analysis excludes *Peronospora lamii* s. str. as a causal agent of the summer savory downy mildew, which is in accordance with recent examinations of *Peronospora* on various hosts of the *Lamiaceae*. These indicate a high degree of specialization, supporting a narrow species concept within downy mildews in general (Göker 2006) and the *P. lamii* complex in particular (Belbahri et al. 2005, Choi et al. 2009, Thines et al. 2009). For example, a downy mildew on *Ocimum basilicum*, previously considered to represent *P. lamii*, turned out to be a different, previously undescribed *Peronospora* species (Belbahri et al. 2005, Thines et al. 2009). Similarly, for downy mildew on *Salvia officinalis* previously assigned to *P. lamii* or *Peronospora swinglei* Ellis & Kellerm. (Müller 1999), a new species, *P. salviae-officinalis*, has been described (Choi et al. 2009). Results of the present examinations of *P. saturejae-hortensis* also support a narrow species concept for the *P. lamii* complex, which appears to contain numerous species with restricted host ranges.

The pathogenicity of the summer savory downy mildew was proven via Koch's postulates in a routine pathogenicity test. It is unknown at this time whether *P. saturejae-hortensis* is capable of causing disease on any other species within the *Lamiaceae*.

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Clarification of *Peziza fimeti* with notes on *P. varia* collections on dung

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Abstract — The smooth-spored species inhabiting dung, mainly of the *Peziza fimeti* group, were studied morphologically and through ITS sequence comparison. The results established that *Peziza varia* is also able to fruit on dung, clarifying a long-standing situation regarding two conflicting interpretations given in *P. fimeti* literature.

Key words — *Pezizales*, taxonomy

Introduction

We re-examined the concepts that have been applied to *Peziza fimeti* (Fuckel) E.C. Hansen (Hansen 1876), a species interpreted differently by various authors. In keys and descriptions *P. fimeti* is reported with two different spore sizes. Bresadola (1892, as *P. fimetaria*, as *Humaria fimetaria*), Seaver (1928), Moser (1963), Romagnesi (1978), Breitenbach (1979), Dennis (1981), Hardtke & Herrmann (1986), Ellis & Ellis (1988), Häffner & Kasparek (1989), Mornand & Péan (1994), Spooner & Butterfill (1999), Dissing (2000), Kutorga (2000), Delgado et al. (2001), Ciana (2003), García (2003), and Poumarat (2008) reported the ascospores measuring (13–)16–18(–18.6) × (6–)8–10(–12) µm. On the other hand, Svrček & Kubička (1961), Gamundí (1975), Donadini (1977, 1978, 1979, 1981), Calonge et al. (1986), Garofoli (1989), Prokhorov & Kutorga (1990), Hallgrímsson & Gøtzsche (1990), Cacialli et al. (1995), Wang & Wang (2000), Hansen et al. (2002), Doveri (2004), Karasch (2005), Pfister & Eyjólfsdóttir (2007), and Moyne & Petit (2008) cited larger spore sizes, (14.1–)18–22.5 × (7.2–)9–12 µm.

This confusion led Hohmeyer (1986) to define two autonomous taxa, "*fimeti* sensu Dennis, Seaver" and "*fimeti* sensu Donadini, Gamundí", distinguished from each other only by the above mentioned spore dimensions. Because of a discrepancy between *P. fimeti* spore sizes as given by Fuckel (1871: 16 × 8 µm) in the protologue and modern measurements from the holotypus (G: 20–22.5 × 10–12 µm), Hansen et al. (2002) suggested that *P. fimeti* sensu Seaver was probably a mistake perpetuated in the literature.

Nevertheless, after we analyzed fresh and dried samples from private and institutional European herbaria, we noted another entity with ascospores similar to those described by Fuckel and to *Peziza alcis* Harmaja. Molecular phylogenetic analysis of the ITS rDNA region showed this latter species is distinct from other *Peziza* spp. on herbivore dung.

Materials & methods

Material studied

We examined both fresh and dried samples (including holotypes) from AMB, FH, G, MCVE, SIENA, TAA(M), and private herbaria. The nine herbarium specimens of *Peziza fimeti* selected for DNA extraction are listed in Table 1.

Table 1. *Peziza fimeti* specimens used in phylogenetic analysis.

Location	Collection data	Habitat	ITS Sequence no.
Italy. Trentino-Alto Adige, Trento, Pozza di Fassa	E. Bizio, 13.08. 94 [pers. herb. EB 130894-32; FH 00301727]	Bovine dung	JQ654487
Italy. Abruzzo, L'Aquila, Civitella Alfedena	E. Bizio, 05.06. 91 [pers. Herb. EB 050691-23; FH 00301728]	Excrement	JQ654488
Italy. Sicily, Siracusa, Buccheri, Santa Maria's Wood	A. Lantieri, 29.10. 05 [pers. Herb. AL 291005-17; FH 00301725]	Bovine dung	JQ654489
Italy. Friuli-Venezia Giulia, Udine, Terzo	A. Pergolini, 15.04. 94 [AMB 002072; FH 00301726]	Equine dung	JQ654490
USA. Alaska, Anchorage, Goose Lake	L. Millman, 07.09. 11 [DHP 11-691; FH 00301724]	Moose dung	JQ654491
Russia. Chelyabinskaya Oblast, Miass	Parmasto et al., 16.07. 73 [TAAM 062922]	Excrement	JQ654492
Russia. Krasnodar, Umpyr, Caucasus Nature Reserve	M. Pallo, 10.08. 76 [TAAM 064318]	Excrement	JQ654495
Russia. Kamchatka, 47 km from Krapivnaya	B. Kullman, 06.08. 78 [TAAM 187900]	Excrement of *Ursus ursus*	JQ654493
Estonia. Jõgevamaa Co, Kursi, Puurmani Commune, Altnurga, forestry sq. 95	M. Öpik, 08.10. 97 [TAAM 171114]	Moose dung	JQ654494

Specimens examined: ***Peziza alcis***: ESTONIA: **Jõgevamaa Co**, Kursi, Puurmani Commune, Altnurga, Forestry sq. 95, on moose dung, 08.10.97, leg. & det. M. Öpik (TAAM 171114, as *P. fimeti*); **Rägavere Comm.**, Uljaste, Lääne-Viru Co., on ground

and on dung, in moist *Betula-Picea* forest, date not declared, leg. K. Kalamees, det. A. Raitviir (TAAM 71260, as *P. fimeti*). **FINLAND**: **Lapland**, Kevo, National Park, on moose dung, 28.08.81, leg. K. Kalamees, det. A. Raitviir (TAAM 122042, as *P. fimeti*); **Uusimaa**, Inkoo, Rådkila, alt. ca 15 m, grid 27° E 6665 : 339, ± mesic acid coniferous health forest, on dung of *Alces*, 09 Nov. 1977, H. Harmaja (H – holotype). **USA**: **Alaska**, Anchorage, Goose Lake, on moose dung, 07.09.11, leg. L. Millman, det. D.H. Pfister (DHP 11-691, as *P. fimeti*; FH 00301724).

Peziza fimeti: **GERMANY**: **Rheinland-Pfalz**, Nassau, auf Kuhmist, in einem Tannenwalde, unterhalb Mappen, Vere, Fuckel (G 00276010, as *Humaria fimeti* – holotype). **ITALY**: **Abruzzo**, L'Aquila, Civitella Alfedena, on excrement, 05.06.91, leg. & det. E. Bizio (pers. herb. EB 050691-23; FH 00301728); **Friuli-Venezia Giulia**, Udine, Codroipo, on equine dung, 16.09.94, leg. & det. A. Pergolini (MCVE 11905); **Lazio**, Roma, Nettuno, 25.11.08, leg. & det. G. Consiglio (pers. herb. GC 08337, as *P. vesiculosa*); **Lombardia**, Brescia, Botticino, S. Gallo, 27.05.00, leg. & det. G. Medardi (pers. herb. GM); Breno, Piana di Gaver, on burnt ground, 23.05.91, leg. & det. G. Medardi (pers. herb. GM, as *P. granularis*); Breno, Piana di Gaver, on bovine dung, 31.05.99, 18.06.01 and 29.06.08, leg. & det. G. Medardi (pers. herb. GM); Pisogne, Val Palot, on bovine dung, 16.05. 96, leg. & det. G. Medardi (pers. herb. GM); Serle, on bovine dung, 29.06.97, leg. & det. G. Medardi (pers. herb. GM); **Piemonte**, Vercelli, Alagna Valsesia, on excrement, 25.06.94, leg. & det. G. Ricci (MCVE 22682); Verbania, Druogno, Val Vigezzo, 15.05.10, leg. & det. G. Medardi (pers. herb. GM, as *P. granularis*); **Trentino-Alto Adige**, Trento, Bersone, on equine dung, 23.06.89 and 18.05.99, leg. & det. G. Medardi, (in pers. herb. GM); Pozza di Fassa, on bovine dung, 13.08.94, leg. & det. E. Bizio (pers. herb. EB 130894-32; FH 00301727); Rabbi, Val di Rabbi, on the ground, 11.09.99, leg. G. Baiano, det. G. Medardi (MCVE 14977, as *P. granularis*); Tonadico, Passo Valles, on bovine dung, 28.06.88, leg. & det. E. Bizio (pers. herb. EB); **Veneto**, Belluno, Taibon Agordino, Valle S. Lucano, on bovine dung, 21.08.01, leg. & det. E. Bizio (MCVE 16013); Venezia, on burnt ground, 19.10.02, leg. & det. E. Bizio, (MCVE 1644, as *P. granularis*); Oasi Ca' Roman, on burnt ground, 03.05.97, leg. & det. D. Garofoli (MCVE 12628, as *P. granularis*); Tonezza Cimone, on bovine dung, 03.06.88, leg. & det. E. Bizio (pers. herb. EB); **Toscana**, Siena, Ginestreto, on bovine dung, 26.01.97, leg. & det. C. Perini (SIENA 2482, as *P. vesiculosa*). **RUSSIA**: **Kamchatka**, 47 Km from Krapivnaya, on excrement of *Ursus ursus*, 06.08. 78, leg. B. Kullman, det. not declared, (TAAM 187899); 47 Km from Krapivnaya, on excrement of *Ursus ursus*, 06.08.78, leg. B. Kullman, det. not declared (TAAM 187900); **Krasnodar**, Umpyr, Caucasus Nature Reserve, on excrement, 10.08.76, leg. M. Pallo, det. A. Raitviir (TAAM 064318); Malaya Laba, Caucasus Nature Reserve, on excrement, 12.08.76, leg. M. Pallo, det. A. Raitviir (TAAM 064369); **Kunashir Island**, Lagunnoye, on excrement, 12.08.70, leg. B. Kullman, det. not declared (TAAM 061513); **Respublika Tyva**, Erzin, on excrement, 18.07.72, leg. B. Kullman, det. not declared (TAAM 065761). **TAJIKISTAN**. **Ramit State Nature Reserve**, Mount Hissar, on excrement, 12.04.77, leg. & det. A. Raitviir (TAAM 064569). **UZBEKISTAN**: Dshisaki, Turkestan Chain, Kulsai, Zaamini Nature Reserve, in *Juniperus* forest, 24.05.80, leg. K. Kalamees, det. A. Raitviir (TAAM 199165).

Peziza varia (collections provisionally assigned to *P. fimeti* sensu Seaver, before morphological and phylogenetic analysis): **ITALY**. **Friuli-Venezia Giulia**, Trieste, Monte Valerio, on equine dung, 19.02.02, leg. & det. F. Bersan (MCVE 23136, as *P. vesiculosa*); Muggia, Rio Storto, on bovine dung, 07.04.94, leg. & det. M. Zugna (MCVE 3637, as *P. vesiculosa*); Udine, Terzo, on equine dung, 15.04.94, leg. & det. A. Pergolini (AMB 002072, as *P. vesiculosa*; FH 00301726); **Trentino-Alto Adige**, Trento, Bersone,

on equine dung, 16.05.89, leg. & det. G. Medardi (MCVE 11322, as *P. fimeti*); VENETO, VENEZIA, Mestre, Parco Villa Franchin, on equine dung, 26.03.98, leg. L. Levorato, det. L. Levorato & A. Camoli (MCVE 13876, as *P. vesiculosa*). RUSSIA: KAMCHATKA, 47 Km from Krapivnaya, on excrement of *Ursus ursus*, 06.08.78, leg. B. Kullman, det. not declared (TAAM 116381, as *P. fimeti*); YAMALO-NENETSKIY AVTONOMNYY OKRUG, Ovgort, on horse excrement and ground near, 28.07.76, leg. Murdvee, det. not declared (TAAM 110066, as *P. fimeti*).

Morphological studies

Microscopic characters were measured and described from material mounted in water or sometimes in 5% KOH to rehydrate dried material. Other mounting media were Melzer's reagent and Cotton blue in lactic acid. Specimens were studied morphologically and photographed using an Optika optical microscope (BK 1301 model) with 40× or 100× (immersion oil) objectives. Spore dimensions were calculated measuring 50 mature spores.

DNA isolation, PCR, and sequencing techniques

Genomic DNA was extracted from the herbarium specimens (TABLE 1) using the Qiagen DNeasy Plant Mini Kit (Qiagen, Germany; cat. no. 69104). A 1/10 and 1/100 dilution of the DNA was used for PCR amplification of the ITS rDNA region using the primers ITS1F (Gardes & Bruns 1993) and ITS4 (White et al. 1990). PCR parameters followed LoBuglio et al. (1993), using 35 PCR amplification cycles performed in a Peltier Thermal cycler PTC–200 (MJ Research, Watertown, MA) using EconoTaq DNA Polymerase (Lucigen, Middleton, WI).

PCR amplification, purification, and sequencing techniques followed Hansen et al. (2005). DNA sequences were edited in Sequencher 4.6 (GeneCodes, Ann Arbor, Michigan). The nine DNA sequences determined in this study were deposited in GenBank (JQ654487- JQ654495).

DNA sequence analyses

DNA sequences were aligned using ClustalW through the Cipres Science Gateway (ML; Miller et al. 2009) and then manually adjusted with Se-Al v 2.0a8 (Rambaut 1996), or Mesquite v 2.75 (Maddison & Maddison 2011). The nine ITS sequences of the *Peziza fimeti* isolates were aligned with 86 ITS sequences of the *Peziza* species included by Hansen et al. (2002) (http://treebase.org/treebase-web/search/study/summary.html?id=900). All data was included in the analyses.

DNA sequence alignments were analyzed using Maximum Parsimony, PAUP 4.0b10 (MP; Swofford 2002) and Maximum-Likelihood with RAxML–HPC2 on Abe through the Cipres Science Gateway (ML; Miller et al. 2009). Due to the large number of trees obtained with parsimony analysis, a Maximum Parsimony phylogenetic search, as outlined by Hansen et al. (1999, 2002) was employed. Each maximum parsimony analysis was performed in two parts as described by Hansen et al (2002): First, 1000 heuristic searches were performed, with random taxon addition and TBR branch swapping, with MAXTREES unrestricted, keeping only up to 15 trees per replicate. Next, exhaustive swapping was performed on all of the most parsimonious trees discovered in the first part of the analysis, with MAXTREES set to 15000. Branch support for MP and ML analyses was determined by 1000 bootstrap replicates. One *Peziza ampelina* Quél. [nom.

illegit., non Pass.] and two *P. subcitrina* (Bres.) Korf sequences were included in this analysis as outgroup.

Results & discussion

Phylogenetic analyses of ITS rDNA sequences place isolate AMB 002072 (identified as *P. vesiculosa* by the collector but as *P. fimeti* sensu Seaver in our

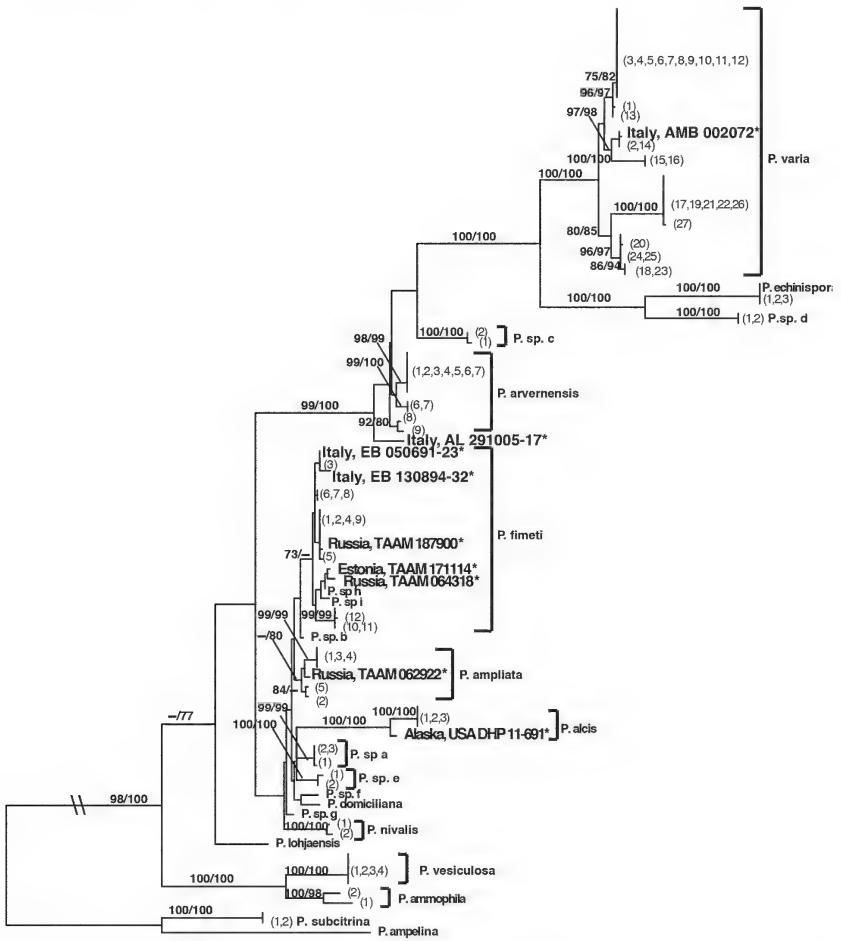

FIGURE 1. Phylogenetic tree of *Peziza* species inferred by Maximum Likelihood. Maximum Parsimony and Maximum Likelihood Bootstrap values above 70% are separated by / and shown either above the branches, or to the left of the branches when space is limited. Branch support for both analyses was determined by 1000 bootstrap replicates. Numbers in parentheses refer to isolate numbers as listed in Hansen et al. (2002). The nine ITS sequences of the *Peziza fimeti* isolates determined in this study are highlighted in bold followed by *.

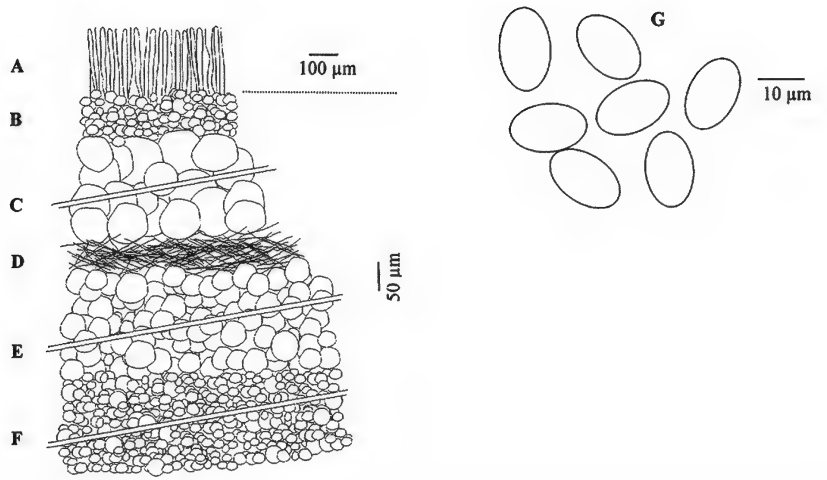

FIGURE 2. *Peziza varia*. Ascoma, vertical section: A. hymenium; B. subhymenium; C. upper medullar excipulum; D. median medullar excipulum; E. lower medullar excipulum; F. ectal excipulum; G. released ascospores.

provisional determinations) in the *P. varia* complex (FIG.1). Within this complex are several well- supported lineages (Hansen et al. 2002; this study, FIG. 1).

The *Peziza varia* complex is a heterogeneous and complicated assembly of widespread species whose diversity has not been well defined. A number of characters are highly variable, such as presence or absence of a stalk, thickness of excipular layers, cell types in the ectal excipulum, and presence or absence of moniliform paraphyses.

ITS analyses highlight the environmentally influenced variability of these morphological characters. The substratum is normally thought to be a very significant taxonomic character in *Peziza* Dill. ex Fr., but the ITS analyses indicate that samples from different substrates and from distant locations can be closely related or conspecific (Hansen et al. 2002).

Peziza varia (Hedw.) Alb. & Schwein. has 25–60 mm diam., more or less regularly cup-shaped, sessile or subsessile apothecia; a smooth, pale brown, pale hazelnut hymenial surface; hygrophanous, grey-brownish to whitish when dry and dark brown if wet, slightly scurfy receptacle surface; and a regular or somewhat wavy margin. Microscopical characters are ascospores that are 14–16(–17.5) × 9–11(–12) µm, smooth as seen in the light optical microscope but slightly warted with SEM (Hansen et al. 2002), hyaline, without oil drops;

FIGURE 3. *Peziza varia*. Fresh ascomata in situ. A. on trimmed wood; B. on trimmed and painted wood of a door; C. on sawdust mixed with soil; D. on burnt residue; E. on papery residue; F. on textile residue; G. on humous soil; H. on sandy soil; I. on gravelly soil; L. on bovine dung.

A
B
C
D
E
F
G
H
I
J

cylindrical, ≤280 µm long asci, clavate to moniliform paraphyses, and a multi-layered excipulum: textura globulosa-angularis subhymenium with 5–12 µm broad cells, a 3–layered medullary excipulum (internal or upper textura globulosa-angularis layer with 20–100(–110) µm broad cells; median textura intricata layer; external or lower textura angularis layer with 20–45 µm broad cells), and an ectal textura globulosa excipulum with 15–20 µm broad cells (Fig. 2).

The habitat of *P. varia* is extremely variable; it can grow on several substrates, such as wood (raw or trimmed, sometimes also painted, occasionally buried), sandy or gravelly, calcareous or acid soil, composted loam, between floor tiles, in cellars or caves, on burnt remnants, and on building, textile, or papery residues.

Our study shows that *P. varia* is also able to grow on dung of herbivores, such as equine or bovine (excluding elks), at times on *Ursus* (Fig. 3). Its occurrence on dung, supported by ITS sequence analyses and morphological comparison with the other similar fimicolous species, probably explains the smaller ascospore sizes for *P. fimeti* given by a number of authors. It is possible that some of the mistaken spore measurements are not due to erroneously transcribing data but that this particular *P. varia* ecological variant has gone unobserved.

Peziza varia shows remarkable morphologic affinities to *P. alcis*, until now recorded only from northern Europe where it is found along paths frequented by elk or on leaf-litter moistened with urine (Harmaja 1986). *Peziza alcis* differs in narrower ascospores (15–16(–17) × 7–9 µm) and a medullary excipulum composed of a single textura globulosa layer with 20–30 µm broad cells (Fig. 4).

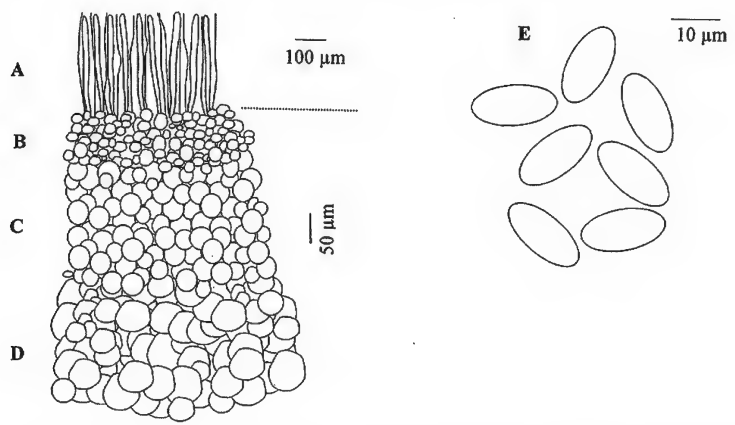

Figure 4. *Peziza alcis*. Ascoma, vertical section: A. hymenium; B. subhymenium; C. medullar excipulum; D. ectal excipulum; E. released ascospores.

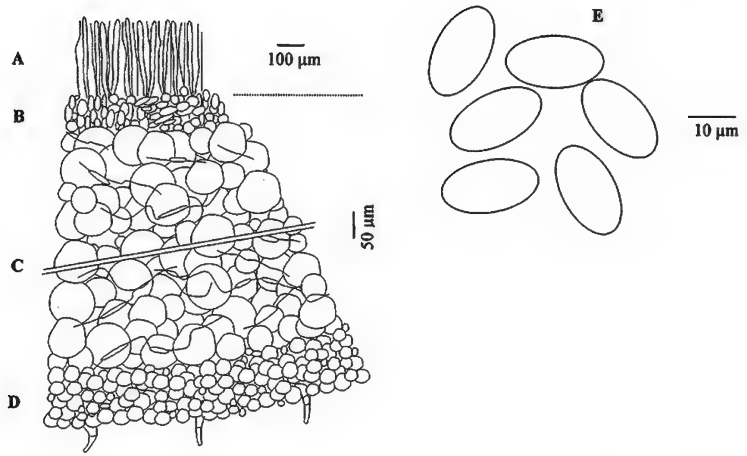

FIGURE 5. *Peziza fimeti.* Ascoma, vertical section: A. hymenium; B. subhymenium; C. medullar excipulum; D. ectal excipulum; E. released ascospores.

Our studies show that *P. alcis* is found in higher circumpolar latitudes (areas frequented by elk), while *P. varia* collected on dung generally comes from lower latitudes where it is not associated with elk.

Peziza fimeti, the most common and widespread species of its group, has been reported worldwide from temperate zones. It fruits on dung of various animals or (at times) on soil or burnt woody remnants (Hansen et al. 2002). It resembles *P. varia* in apothecial colour but has larger ascospores ((18–)20–22.5 × 10–12 µm) and a medullary excipulum composed of a single textura globulosa layer with 50–100 µm broad cells (FIG. 5). These characters, as well as apothecial size and shape, also distinguish *P. fimeti* from *P. vesiculosa* Bull., with which is often confused.

Two specimens provisionally determined as *P. fimeti* sensu Seaver were found not to belong in *P. varia*. Molecular analyses (FIG. 1) of the first sample, TAA(M) 062922 (previously studied by Hansen et al. (2002) cluster it with *P. ampliata* Pers., which normally fruits on woody residue and marsh herbaceous stems (Donadini 1981) or burnt ground (Dougoud 2001). However, dried apothecia are small, cup-shaped and thin instead of turbinate and thick, and also the structural study did not show the characteristic large cells (≤220–240 µm) usually observed in the medullary excipulum of *P. ampliata*. We have been unable to resolve the identity of this taxon. Our molecular analyses place the second divergent collection (AL 291005-17; FH 00301725) in a clade including *P. varia*, *P. arvernensis* Roze & Boud., and *P. echinospora* P. Karst.; its correct identity is also still not understood.

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New taxa of *Hymenochaete* (*Agaricomycetes*, *Hymenochaetales*) with a note on *H. caucasica*

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Abstract — Five new species of *Hymenochaete*, *H. cystidiata*, *H. fuscotestacea*, *H. leppii*, *H. patellaris*, and *H. spinulosetosa*, and a new subspecies, *H. muroiana* subsp. *africana*, are described. *Hymenochaete caucasica* is redescribed and accepted as a distinct species and not a synonym of *H. minuscula.*

Key words — patelliform basidioma, spiny setae, *Hymenochaete pellicula*

Introduction

The author has studied the *Hymenochaetaceae* for over fifty-five years, beginning in 1957 with a paper on *Inonotus obliquus* (Parmasto 1957). In this paper five new species and one new subspecies of *Hymenochaete* are described. The taxa are from Australia, Brazil, Cameroon, Kenya, and Venezuela. In addition, *H. caucasica* from Georgia is redescribed.

Materials & methods

This study is based on herbarium specimens deposited in the herbaria BPI, CANB, E, K, O, S, and TAAM. Color notations are given using Munsell (1976, abbreviated M) and Kornerup & Wanscher (1967, abbreviated K & W). Spore size was measured, and *Q* (length/width quotient) values calculated as described in Parmasto (2006). Herbarium acronyms follow Thiers (2012).

Taxonomy

Hymenochaete cystidiata Parmasto, **sp. nov.**

MycoBank MB 564943

Basidiomata resupinata, ad 200 µm crassa. Tomentum et cortex desunt, stratum hypharum bene evolutum. Systema hypharum subdimiticum. Setae subulatae, acutae, sine

†Dr. Erast Parmasto, who had almost completed this paper at the time of his death, passed away on April 24, 2012. The paper presented here was prepared for publication by Karen K. Nakasone.

incrustatione, 60–100 × 7–10(–11) µm. Cystidia dispersa, cylindrica, tunicis incrassatis, 18–30 × 7–9 µm. Sporae subcylindricae, 4.8–5.8(–6.2) × (2.3–) 2.5–3.2 µm.

Type: Cameroon. S.–W. Province (Southwest Region): Korup Forest Reserve, Mundemba, on fallen branches, 8 Apr 1990, R. Watling 22123 (**Holotype,** E 60207; **isotype,** TAAM 202698).

Etymology: '*cystidiata*', with cystidia.

Basidiomata effuse, adnate but removable as pieces, soft coriaceous, 80–200 µm thick, up to 15 cm long. Hymenium smooth, azonate, not cracked, vinaceous buff (M: 7.5 YR 7/3; K & W: 5 C 3), without olive or lilac tint; margin 1–2 mm wide, indistinct or arachnoid, yellowish when young (M: 7.5 YR 8/10; K & W: 5 B 6).

Tomentum and cortex absent; hyphal layer composed of more or less loosely interwoven hyphae.

Hyphal system subdimitic; setal hyphae absent; generative hyphae 2–3 (–4) µm diam, with brownish, thickened walls, sparsely branched and with few septa, or partly thin-walled and hyaline. Hymenium with hyaline or yellowish conglomerates of crystalline or amorphous matter, 8–20 µm diam. Setae scattered or sometimes in groups, subulate to long-conical, with acute tip, straight, 60–100 × 7–10(–11) µm, usually enmeshed in hyphal sheath, without incrustation. Cystidia scattered, cylindrical, with rounded tips, 18–30 × 7–9 µm, with thickened walls (except in distal part), not encrusted; Hyphidia absent. Basidia clavate, 15–22 × 4.5–5.5 µm, with 4 thin sterigmata about 3 µm long. Basidiospores elongate ellipsoid, nearly subcylindric, with one side slightly concave, hyaline, thin-walled, 4.8–5.8(–6.2) × (2.3–)2.5–3.2 µm, average of 25 spores: 5.4 × 2.8 µm, $Q = 1.95$.

Remarks—Cystidia in species of *Hymenochaete* are atypical in that they appear to be differentiated hyphal ends that are often encrusted hyphidia, basidioles, or thin-walled setae with a rounded tip. In *H. cystidiata* the cystidia seem to be analogous with basidioles and are not true cystidia as found in corticioid *Polyporales*.

Hymenochaete fuscotestacea Parmasto, **sp. nov.**

MycoBank MB 564949

A H. cinnamomea *hyphis crassitunicatis granulosis moniliformibus, hyphidiis spinosis, et basidiosporis late ellipsoideis 4.8–5.4(–5.6) × (3.2–)3.3–3.9(–4) µm differt.*

Type: Venezuela, Aragua Province, Parc National Henri Pittier, Rancho Grande, on angiospermous wood on the ground, 29 Aug 1999, K.-H. Larsson 11024 (**Holotype**, O; **isotype**, GB).

Etymology. '*fusco-*', dark; '*testaceus*' brick-red.

Basidiomata effuse, adnate but removable as pieces, soft coriaceous, 400–800 µm thick, rounded. Hymenium smooth, azonate, not cracked, dark Brick to

Umber (M: 2.5–5 YR 4/4; K & W: 7 E–F 8), without olive or lilac tint; margin indistinct or arachnoid, concolorous with the hymenium.

Tomentum and cortex absent; hyphal layer composed of loosely interwoven hyphae.

Hyphal system monomitic; setal hyphae absent; generative hyphae with thickened or thick walls, branched at right angles, with numerous septa, brown, 3.5–4.5(–5) µm diam, partly with monilioid wall thickenings (similar to those in *H. semistupposa* Petch and *H. yasudae* Imazeki). Setae numerous, subulate, with acute tip, straight, (50–)55–80 × 6–8 µm, some enmeshed in hyphal sheaths, without incrustation. Hyphidia numerous, cylindrical, up to 6 µm diam, with numerous septa, yellowish, with thickened walls covered with granules, then with densely arranged, small, upward pointed thorns. Basidia clavate, 12–18 × 5–6 µm, sterigmata 4, thin, about 3 µm long. Basidiospores broadly ellipsoid, 4.8–5.4(–5.6) × (3.2–)3.3–3.9(–4) µm (average size: 5.1 × 3.6 µm; Q = 1.4).

Remarks—The loosely interwoven septate, branched hyphae of the context and size and form of setae in *H. fuscotestacea* are similar to *H. cinnamomea* (Pers.) Bres. However, *H. cinnamomea* lacks monilioid hyphae and has smaller, cylindrical to ellipsoid spores, average size 5.0–6.7 × 2.1–2.8 µm; Q = 2.0–2.8. The unusual, thorny, claw-like outgrowths of the hyphidial walls are similar to that found in *H. mollis* Bres. In a less pronounced form, these outgrowths also occur in some specimens of *H. cinnamomea.*

According to a cladistic analysis of molecular data, *H. fuscotestacea* (as *Hymenochaete* sp.) clustered with *H. rubiginosa* (Dicks.) Lév. and *H. cinnamomea* (Larsson et al. 2004).

Hymenochaete leppii Parmasto, **sp. nov.**

MycoBank MB 564944

Basidiomata patelliformia, ad 1(–3) mm crassa, molle. Systema hypharum monomiticum, hyphae dichotomae vel ad angularum 90° patentes. Dendrohyphidiae abundae. Sporae naviculare (5.0–)5.2–6.2(–6.5) × (2.2–)2.4–2.8(–3.0) µm.

Type: Australia, Tasmania, Mt. Field National Park, Lyrebird Nature Trail, mixed rainforest, 7 Apr 2000, H. Lepp 2717 (**Holotype**, CANB 627018; **isotype**, TAAM 091457).

Etymology: (Heino) '*Lepp*', Australian collector of fungi and lichens.

Basidiomata patelliform, effuse with slightly raised or narrowly reflexed margins, soft, cottony, fragile, up to 5 cm in diam, then confluent, (200–) 500–1000(–3000) µm thick. Abhymenial surface uneven, minutely tomentose, dark Sienna or cognac brown (M: 7.5 YR 4/8 or 5/10; K & W: 6 D–E 7). Hymenium uneven, sometimes slightly concentrically sulcate, grayish light Umber (M: 7.5 YR 5/4–6 to 4/4; K & W: 6 E 3–4 or 6 D–E 5), in old specimens brown (M: 7.5 YR 5/8–10 to 5 YR 4/8); margin abrupt, light Fulvous (M: 7.5 YR 7/10; K & W: 5 C–D 7), then Fulvous (M: 7.5 YR 5/10). Context densely soft, cottony.

Abhymenial surface densely covered with short, thin dendrohyphidia-like brownish hyphae.

Tomentum and cortex absent; hyphal layer composed of rather densely interwoven, but distinct, not agglutinated hyphae.

Hyphal system monomitic; setal hyphae absent; generative hyphae (2–)3–4(–5) in diam, with slightly thickened walls, brownish, moderately branched, mainly at right-angles or dichotomously, with numerous septa. Setae numerous, 80–130(–150) × (5–)7–12 μm, emerging up to 100 μm or more above the hymenial level, subulate, with acute tip, straight, without incrustation. dendrohyphidia numerous in hymenium, distinct, simple or usually forked or 2–3 times branched, with thin branches, up to 5–6 μm diam in base, brownish, similar to context hyphae. Basidia clavate, with 4 thin sterigmata. Basidiospores navicular, in holotype (5.0–)5.2–6.2(–6.5) × (2.2–)2.4–2.8(–3.0) μm (average 5.7 × 2.6 μm; $Q = 2.2$).

Additional specimens examined — **Australia, New South Wales**: Parkers Gap, Tallaganda State Forest, 7 km SE of Captains Flat, wet *Eucalyptus* forest, on side of a fallen rotten trunk, 5 Aug 1992, H. Lepp 870 (CANB 569442; TAAM 091443); Red Rock, 30 km NNE of Coffs Harbour, mixed subtropical vegetation with *Eucalyptus* and *Casuarina* dominant, underside of long-dead wood on the ground, 19 Apr 1998, H. Lepp 1937 (CANB 569454; TAAM 091440).

Remarks—Only two other *Hymenochaete* species have patelliform basidiomata, i.e., plate-like with defined free margins — *H. patellaris* and *H. patelliformis* G. Cunn. Both lack dendrohyphidia and have somewhat smaller spores. Hyphae of *H. leppii* resemble dichohyphae of *Dichochaete* spp. (see Parmasto 2001: 56–57).

Hymenochaete muroiana subsp. ***africana*** Parmasto, **subsp. nov.**

MycoBank MB 564945

A Hymenochaete muroiana *subsp.* muroiana *setis (30–)35–60(–80) μm longis basim ad normam non bifurcatis, basidiomatis 50–80 μm crassis differt.*

Type: Kenya. Eastern Province, Aberdare Mts., Kimakia Forest Sta. (0°45′S, 36°50′E), alt. c. 2200–2400 m, 16–18 Jan 1973, L. Ryvarden 8900 (**Holotype**, O; **isotype**, TAAM 132384).

Etymology: '*africanus*', growing in Africa.

Basidiomata effuse, closely adnate, hard when dry, as rounded patches 5–15 mm diam, then confluent, up to 50 mm long, thin, 50–80 μm thick; hymenium smooth, azonate, irregularly cracked when old, Umber or tobacco brown (M: 5 YR 5–4/4; K & W: 7 E 6-7), without olive or lilac tint; margin distinctly delimited, concolorous with hymenium.

Tomentum, cortex, and hyphal layer absent or hyphal layer indistinct from thin, dark brown setal layer, 10–25 μm thick; dark line above the hymenium absent; no crystals in context or in hymenium.

Hyphal system monomitic; hyphae of context densely agglutinated, with thickened walls, 2–3 µm in diam. Setae numerous, (30–)35–60(–80) × 6–8(–9) µm, projecting 20–50 µm above the hymenium, subulate, some with L-shaped base, thick-walled, with acute tip, sometimes upper part slightly curved, usually with a thin hyphal sheath. Cystidia absent. Hyphidia absent. Basidioles few. Basidia subcylindrical or subutriform, 15–20 × 4–5 µm; sterigmata 4, thin, 3–4 µm long. Basidiospores broadly ellipsoid, (4.3–)4.5–5.5(–5.6) × (2.8–)3–3.5 (–3.7) µm (average of 25 spores: 5.1 × 3.2 µm, $Q = 1.6$).

On a dead bamboo; causes a white fibrous rot.

Remarks—Subspecies *africana* is morphologically similar to subsp. *muroiana*, which differs in shorter setae, 18–40(–50) × 5–8 µm, with bifurcate base and thinner basidiomata, 15–40 µm thick. In addition, subsp. *muroiana* is widely distributed in eastern Asia, Indochina, and Hawaii (Parmasto 2005a,b).

Hymenochaete patellaris Parmasto, **sp. nov.**

MycoBank MB 564946

A Hymenochaete patelliformis *hyphis sceletoidibus in strato hypharum, setis obtusis apicibus, basidiosporis grandibus, 4.5–5.5(–6) × 2.5–3.2 µm differt.*

Type: Brazil. Rio Grande do Sul, Serra Azul, 1925, J. Rick (**Holotype**, BPI 277472).

Etymology: '*patellaris*', like a shallow dish.

Basidiomata seemingly effuse, but really patelliform, soft coriaceous, up to 3 cm diam, then confluent, 50–80 µm thick; abhymenial surface uneven, dark Fulvous (M: 7.5 YR 5/7; K & W: 6 D 6–7), near margin slightly lighter; hymenium uneven, with a few cracks, sometimes concentrically sulcate, slightly lighter colored than abhymenium; margin abrupt.

Tomentum, cortex and hyphal layer present; dark line present above the hymenium; no conglomerates of crystals in context or hymenium.

Hyphal system (sub)dimitic; skeletal hyphae of the hyphal layer more or less parallel, loosely intertwined, with thickened or thick walls, brown, 2–3 µm in diam; generative hyphae thin-walled, yellowish. Setae numerous, subfusoid, thick-walled, with blunt tip, 22–35(–40) × 4.5–6.5(–7) µm, projecting up to 20 µm above the hymenium, covered with a hyphal sheath. Cystidia absent. Hyphidia absent. Basidioles few. Basidia subcylindrical or subutriform, sterigmata 4, thin, 3–4 µm long. Basidiospores broadly ellipsoid or subcylindric, 4.5–5.5(–6) × 2.5–3.2 µm (average of 30 spores: 5.1 × 2.8 µm, $Q = 1.8$).

Remarks—*Hymenochaete patellaris* is possibly closely related to *H. patelliformis* from New Zealand, which differs in setae with acute tip, 25–50 × 5–6(–7) µm, smaller ellipsoid spores (2.5–)3–4 × 1.5–1.8 µm, and absence of skeletal hyphae

in the hyphal layer. Skeletoid hyphae are present in the hyphal layer of *H. cacao* (Berk.) Berk. However, *H. cacao* has pileate, dimidiate to flabelliform basidiomata, densely compacted hyphae, unsheathed and acute tipped setae, and smaller basidiospores (2.8–)3.5–4 × (1.8–)2–3 μm.

Hymenochaete spinulosetosa Parmasto, **sp. nov.**

MycoBank MB 564947

A speciebus Hymenochaetes *setis spinosis basidiomatibus 700–1000 μm crassis, setis longis (45–)50–75(–90) × 5–7.5(–9) μm, basidiosporis grandibus 5–6.2(–6.5) × (3–)3.2–3.7 μm differt.*

Type: Venezuela. Prov. Merida, Monte Zerpa by Merida, alt. 2000 m, on dead hardwood, 29 Jan 2001, L. Ryvarden 43707 (**Holotype**, O; **isotype,** TAAM 202926).

Etymology. '*spinula*', spike, thorn; '*seta*', seta

Basidiomata effuse, closely adnate, hard woody when dry, as rounded patches 1–2 cm long, then confluent, thick (up to 700–1000 μm); hymenium smooth, azonate, irregularly deeply cracked when old, brown (M: 5 YR 4/2–3; K & W: 6 E 4–5), without olive or lilac but sometimes with grayish tint; margin distinctly delimited, concolorous with hymenium.

Tomentum, cortex and hyphal layer absent; dark brown setal layer thickening, but distinct dark line absent; crystals absent in context and hymenium.

Hyphal system monomitic; hyphae of the setal layer densely agglutinated, with thickened walls, brown, 2–4(–5) μm diam. Setae numerous, subulate, thick-walled, with acute tips, (45–)50–75(–90) × 5–7.5(–9) μm, projecting 20–45 μm above the hymenium, thorny, usually with 3–5(–8) small spikes, 1.5–3(–4) μm long or subspherical protuberances 1.2–1.8 μm diam, some with a thin hyphal sheath. Cystidia absent. Hyphidia numerous, with thin yellowish walls, 1.5–3 μm diam. Basidia subcylindrical to subutriform, 12–20 × 4–5.5 μm; sterigmata 4, thin, 3.5–4 μm long. Basidiospores broadly ellipsoid, with one side flattened, 5–6.2(–6.5) × (3–)3.2–3.7 μm.

Remarks—There are six species of *Hymenochaete* with thorny setae composed of few to 8–10 spiny to subspherical protuberances. They differ from *H. spinulosetosa* in having non-thickening basidiomata, 50–150 μm thick, shorter setae, 40–60(–70) μm long, and shorter spores, 3–4.5 μm long, except in *H. pellicula* Berk. & Broome the spores are up to 5 μm long. Two species, *H. separabilis* J.C. Léger and *H. tomentelloidea* Gilb. & Hemmes, have a well-developed hyphal layer. *Hymenochaete spinulosetosa* is the only species of this group found in America.

Hymenochaete spinulosetosa may be related to *H. pellicula* which was found only once in Sri Lanka and described by Petch (1925: 278) and Léger (1998: 214). The holotype was examined (K, Ceylon no. 990); it has a thin basidiomata up to 50 μm thick, short setae 45–65 × 5–7 μm, and small basidiospores 4.5–5.5 ×

2.5–3.5 µm. *Hymenochaete pellicula* was reported from Philippines by Bresadola & Sydow (1914: 351) and Bresadola (1915: 302), but the specimens cited in these papers obtained from BPI, K, and S were identified as *H. muroiana* or *H. murina* Bres.

Hymenochaete caucasica Parmasto, Mikol. Fitopatol. 20 (5): 374. 1986.

Basidiomata annual (?), effuse, adnate, suberose, 0.5–2 cm in diam, then confluent and up to 10 cm long, thin, 40–120 µm thick; hymenium smooth, pale to dark ochraceous (M: 7.5 YR 6.5/6 to 7.5/5; K & W 5 B–C 4 to 5 C 4–5); margin thin, farinose, concolorous with the hymenium.

Tomentum, cortex and setal layer absent; hyphal layer composed of densely interwoven hyphae.

Hyphal system monomitic; setal hyphae absent. Generative hyphae with thin or thickened walls, branched, septate, brown, 2.2–3.5 µm diam. Setae narrowly conical, with acute tip, 28–45(–53) × 4.5–7.5(–9) µm, projecting up to 25 µm above the hymenium. Hyphidia few, cylindrical, hyaline or yellowish, thin-walled, 2–3.5 µm diam. Basidia slightly utriform, 10–16 × 3.7–5 µm, sterigmata 4, thin. Basidiospores short-cylindrical, slightly curved, 4.5–5.6 (–6.0) × 2–2.5 µm (average size 4.9 × 2.2, $Q = 2.2$).

Specimens examined: **GEORGIA. Tshakva Distr.**, Thigeri, on fallen twigs of *Buxus colchica* Pojark., 28 Sep 1963, E. Parmasto (Holotype, TAAM 016997); Hulo Distr., Bakho, alt. 1700 m, on a fallen trunk of *Abies nordmanniana* (Steven) Spach, 3 Oct 1963, E. Parmasto (TAAM 016035).

Remarks—Léger (1998: 86, 191) synonymized *H. caucasica* with *H. minuscula* G. Cunn. Originally described from New Zealand (Cunningham 1957), *H. minuscula* has been reported from Réunion (Western Indian Ocean, det. Léger), Argentina (Job 1990), Brazil, Colombia, Jamaica and Venezuela (Escobar 1978). I have studied the isotype of this species (BPI 278247; Léger studied the holotype, PDD 11242). *Hymenochaete minuscula* differs from *H. caucasica* by a darker hymenium (M: 7.5 YR 5/7), larger setae, sometimes slightly sinuose, with a slightly curved tip, (45–)50–65(–70) × (6–)7–9(–10) µm, and larger basidia about 20 × 5–6 µm. The basidiospores of *H. minuscula* described by Léger are 4–5 × 1.8–2.2 µm, smaller than in *H. caucasica*. In the isotype studied, basidiospores were few and decayed. The distributions of *H. caucasica* and *H. minuscula* are quite different. Because of these differences, I prefer to recognize the species as separate taxa.

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Book reviews and notices

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Introduction

Many new mycological taxonomic publications have seen the light this year, with only a handful of them reviewed in this installment and some more mentioned under Book announcements. Several issues of the series Studies in Mycology are presented here, followed by books on lichens, and studies of various genera in the *Agaricales*. For two books, updated second editions came out, which are discussed.

Ascomycetes

***Colletotrichum:* complex species or species complexes?** By U. Damm, P.F. Cannon & P.W. Crous (eds). 2012. Studies in Mycology no. 73. CBS-KNAW Fungal Biodiversity Centre, P.O. Box 85176, 3508 AD Utrecht, The Netherlands. <info@cbs.knaw.nl>. Pp. 215, illustr. ISBN 978-90-70351-92-2. Price: 65 € (paper copy, download free)

Getting to grips with species concepts in large and complex groups of fungi remains a major challenge, even with the advantages now available through molecular phylogenetics. It is also incumbent upon mycologists to generate taxonomies that will be meaningful to the users of names, such as plant pathologists in the case of *Colletotrichum*. A step-wise approach is therefore both essential and appropriate, and this number of Studies in Mycology does just that, with in-depth studies of three species complexes: those of *C. boninense* (Damm et al., pp. 1–36), *C. acutatum* (Damm et al., pp. 37–113), and *C. gloeosporioides* (Weir et al., pp. 115–180).

* Books for consideration for coverage in this column should be mailed to the Book Review Editor at the address above. All unsigned entries are by the Book Review Editor.

Colletotrichum boninense proved to comprise 18 clades, recognized as separate species, and necessitating the description of 12 new species, seven of which were from New Zealand. A parallel situation was revealed in *C. acutatum* where 31 species were distinguished, of which 21 were new. Further, 22 species and one subspecies were recognized in *C. gloeosporioides,* seven species being new to science. ITS sequences alone were unable to differentiate some species in the last complex, and there multi-gene diagnostics will be essential, as several taxa are of biosecurity significance. In all three groups, the generic name *Colletotrichum* is adopted, rather than *Glomerella,* whether or not a sexual state is known.

In a final contribution, Cannon et al. (pp. 181–123) provide a perspective of the current state of the taxonomy of the genus, and indications of future directions. Notes are provided on the situation in other clades not treated in the earlier contributions, and an eventual infrageneric classification is seen as highly desirable. They recognize that a suitable barcode will be needed, and that in such a complex and economically important group a consensus approach should be sought. In order to progress that vision, a subcommission of the International Commission on the Taxonomy of Fungi on *Colletotrichum* is being established.

The standards of the presentation and the photographs are superb, and it was especially pleasing to see the appressoria of so many species so well illustrated.

The issue is dedicated to Brian C. Sutton, who served as a mycologist at the former International Mycological Institute (Kew and Egham) from 1959–1965 and 1969–1995. Brian, doyen of the coelomycetes, had a particular interest in the genus on which he published several seminal papers between 1962 and 1992. In common with many who have struggled to identify these fungi, I am sure that he will have been amazed to see how complex some of these fungi are, at last understood why some seemed so variable and difficult to resolve by morphology alone, and pleased to see a new taxonomy emerging.

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The genus *Cladosporium*. By K. Bensch, U. Braun, J.Z. Groenewald & P.W. Crous. 2012. STUDIES IN MYCOLOGY no. 72. CBS-KNAW Fungal Biodiversity Centre, P.O. Box 85176, 3508 AD Utrecht, The Netherlands. <info@cbs.knaw.nl>. Pp. 401, illustr. ISBN 978-90-70351-91-5. Price: 70 € (paper copy, download free)

A comprehensive revision of *Cladosporium* has been desperately required for over 50 years, and at last it is here. Important contributions clarifying

the generic circumscription or providing critical molecular phylogenetic treatments of particular groups have appeared during the last 15 years, most notably by David (1997) and the present authors, especially in earlier numbers of Studies in Mycology (see Mycotaxon 107: 507–509, 2009; 114: 487–500, 2010). This new monographic treatment brings all this information together and so will be the key work on the genus for decades to come. The now 993 species names in *Cladosporium* (and its synonym *Heterosporium*) result in 169 accepted species. The sexually typified *Davidiella* is wisely treated as a synonym in accordance with the demise of dual nomenclature in pleomorphic fungi (on 30 July 2011—not from 1 January 2013 as mentioned on pp. 10–11). The genus is monophyletic, with the asexual states characterized by coronate hila formed at conidiogenesis and the sexual states differing from *Mycosphaerella*, as the ascospores, where known, have characteristic irregular inclusions.

Following an historical introduction and description of the diagnostically important characters are a series of nine keys, which have been pragmatically produced. These include ones based on host and substrate and also separate keys to the main complexes, *C. cladosporioides* and *C. herbarum*. The *C. cladosporioides* complex, so important in indoor environments, has swelled to 46 species that can be more-or-less separated morphologically, but they note that there are further cryptic species that may merit recognition in future.

The accepted species are arranged alphabetically, and for each there are superb illustrations, both photomicrographs and line drawings, some accompanied also by photographs of infections on host plants or scanning electron micrographs. Careful attention is paid to the nomenclature, synonymy, and typifications, and in addition to the expected detailed descriptions there are also references to previously published illustrations, exsiccates, and information on host ranges and distributions. Contrary to common misconceptions, only a limited number of species are plurivorous or widely distributed.

Excluded species are discussed in detail, and new combinations made for several into other genera, especially *Zasmidium*. Uncertain and doubtful species are discussed in a separate section, often with illustrations even though the current placements are unsure. In such a complex work, I was pleased to find comprehensive indices to both hosts and fungal names.

This will be a key work for plant pathologists and mycologists concerned with indoor moulds and spoilage who must have it to hand. No longer will it be precise enough to just use names such as '*C. cladosporioides*' without a more critical examination. And at such a modest price, and availability at no cost through the CBS website, there can be no excuse not to be more precise. This splendid work is yet another pinnacle of achievement for a group of

extraordinarily skilled mycologists, to whom all others will remain even more in debt than they already were.

David JC. 1997. A contribution to the systematics of *Cladosporium*: revision of the fungi previously referred to *Heterosporium*. MYCOLOGICAL PAPERS 172: 1–172.

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A monograph of *Allantonectria*, *Nectria* and *Pleonectria* (*Nectriaceae*, *Hypocreales*, *Ascomycota*) and their pycnidial, sporodochial and synnematous anamorphs. By Y. Hirooka, A.Y. Rossman, G.J. Samuels, C. Lechat & P. Chaverri. 2012. STUDIES IN MYCOLOGY no. 71. CBS-KNAW Fungal Biodiversity Centre, P.O. Box 85176, 3508 AD Utrecht, The Netherlands. <info@cbs.knaw.nl>. Pp. 210, illustr. ISBN 978-90-70351-90-8. Price: 65 € (paper copy, download free)

The *Hypocreales* is one of the most intensively researched orders of fungi, and it is mildly surprising that *Nectria* (in its current restricted circumscription) has not previously been the subject of a large-scale monograph in the STUDIES IN MYCOLOGY series. This publication addresses that omission very satisfactorily, alongside a detailed treatment of two other genera of the *Nectriaceae*, the monotypic *Allantonectria* and the more speciose *Pleonectria*. These three genera, shown to be individually monophyletic based on a six-locus phylogenetic analysis, collectively form a paraphyletic assemblage with *Nectria* itself sister to a cluster of other nectriaceous genera including *Calonectria* and *Neocosmospora*. The three genera studied here can be separated with relative ease using morphological criteria, with *Nectria* separated from *Allantonectria* and *Pleonectria* based on absence/presence of yellow scurfy cells on the ascomatal walls and on conidioma and conidiophore morphology. *Allantonectria* has aseptate allantoid ascospores, in contrast to *Pleonectria* where they are septate (frequently multiseptate and/or muriform) and in most species bud to form conidia directly from the germinating ascospore.

The type species of *Nectria, N. cinnabarina,* is one of the most familiar microfungi in northern Europe, especially as its "coral spot" anamorph, which is almost ubiquitous in the region as a weak pathogen of woody plants. Building on work published in an earlier volume of STUDIES IN MYCOLOGY (Hirooka et al., 2011), it is now considered to be one of a complex of four cryptic species that are unequivocally separated using sequence data but which can hardly be distinguished on morphological criteria. The authors provide an explanation of their interpretation of species concepts in the *Nectriaceae*, favouring a polyphasic approach. However, the inclusion of phylogenetic/genealogical

concordance as the primary method (or one of the primary methods) of species differentiation seems inevitably to lead to a proliferation of taxa and difficulties when attempting to correlate modern species concepts with historical data. For example, a report referred to without comment of *N. cinnabarina* as an endophyte of *Taxus mairei* in China is at odds with the geography and ecology of that taxon as defined in the current volume. Using the wealth of historical literature on fungal systematics and biology in the context of modern phylogenetic species concepts is one of the twenty-first century's greatest challenges, and one that goes far beyond the bounds of this volume.

Publication in Studies in Mycology is not in itself an absolute guarantee of quality, but few other publication series covering fungal systematics come close to it for utility, presentation and scientific rigour. The current volume is not perfect — it could have done with more attention to proof-reading and some of the illustrations are not of the highest quality — but it will constitute the standard reference for the genera concerned for some years to come.

Hirooka Y, Rossman AY, Chaverri P. 2011. A morphological and phylogenetic revision of the *Nectria cinnabarina* species complex. Studies in Mycology 68: 35–56.

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Taxonomic manual of the *Erysiphales* (powdery mildews). By U. Braun & R.T.A. Cook, 2012. CBS Biodiversity Series 11. CBS-KNAW Fungal Biodiversity Centre, P.O. Box 85176, 3508 AD Utrecht, The Netherlands. <info@cbs.knaw.nl>. ISBN 978-90-70351-89-2. Pp 707. Price 80 €

The powdery mildews are often ignored by field mycologists because they look rather uninteresting and require a microscope to identify. Luckily this impression is not shared by all, and the authors of this fine new book have provided abundant evidence to support much more research into the group. Following on from Braun's monograph of 1987 and his account of European species in 1995, this collaboration with Cook has laid a modern foundation for future work. These fungi have had a chequered taxonomic history with differing approaches by 'lumpers' and 'splitters' and by plant pathologists and mycological taxonomists.

The book begins with a review of the classification of the *Erysiphales* and the pathways by which the latest systems have been developed. Detailed accounts of structure, especially of the anamorphs, are accompanied by a wide range of drawings and microphotographs. Detailed keys allow identification either via the host family or by examination of the fungi themselves. Descriptions

of all known species are clear and convincing and all include drawings of the diagnostic features. Host information is generally full and distribution data is most helpful, although necessarily not without some minor omissions. Comprehensive indices and a useful glossary complete a tour-de force.

Using modern molecular techniques it can be demonstrated that the *Erysiphales* have evolved in a close partnership with their hosts and the systematics of the group closely mirrors that of the angiosperms. Host specificity is high and we now have a review of the world's species that will allow for far easier identification of the vast majority of taxa. The separation of species of *Golovinomyces* on hosts from different tribes in the *Asteraceae* is now clear, as is the division of *Podosphaera fusca* into a number of more narrowly defined taxa on the same host family. In addition, the breaking up of the *Leveillula taurica* complex and the separation of host-specific species in *Phyllactinia* will greatly assist confident naming of these fungi.

A major feature of the book is the reliance on anamorph characters and the erection of different form-genera for the anamorph states, classified within the tribes of the teleomorphs. This will allow for a quicker placement of the many un-associated anamorphs to the correct perfect genus and, subsequently, their absorption into existing species or description as new.

All reviewers are expected to find some fault but this is very difficult in this case. Perhaps the inclusion of three colour plates, rather fuzzy and not exciting, was a small mistake and the fact that the index does sometimes fail to lead to the fungus listed (pages and species numbers are in a few cases confused), and some of the distribution data is incomplete. But these are very minor quibbles.

The combination of traditional and molecular taxonomy is a timely justification for both approaches and the writers are to be congratulated on producing a truly magnificent work. The publishers too deserve praise for providing such a well-produced book at a really modest price.

This book should be in the library of all plant pathologists and also all those mycologists who are interested in the co-evolution of fungi and plants. The greatest praise that this reviewer can add is that he wishes that he had written this book, it is so good!

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Braun U. 1995. The powdery mildews *(Erysiphales)* of Europe. Fischer, Jena.

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Lichens

Biomonitoring, ecology and systematics of lichens. Recognizing the lichenological legacy of Thomas H. Nash III on his 65th birthday. By S.T. Bates, F. Bungartz, R. Lücking, M.A. Herrera-Campos & A. Zambrano (eds), 2011. Bibliotheca Lichenologica Band 106. ISBN 978-3-443-58085-8. Pp. 442, col. pl. 16, figs 102. Price 109 €

It is most fitting that Tom Nash should be honoured on the occasion of his 65th birthday and retirement from Arizona State University, where he was based for 40 years and developed both his personal reputation and a major lichen collection. The high regard in which Tom is held by his students and peers is evident from the size of this book, which includes no fewer than 33 original contributions. These reflect Tom's research in systematics, ecology, and bioindication, but those on systematics predominate here, though five concern air quality issues. As is almost always the case in such volumes where space is generally restricted, the majority of papers deal with one or a few species. It would not be practical to mention all these here, but some are of wider interest: the recognition of *Haplospora* as distinct from *Merismatium* (Hafellner, pp. 75–93), the introduction of the new generic name *Malmidea* in the new family *Malmideaceae* for tropical lecideoid lichens on trees, many of which were previously placed in *Malcolmiella* (Kalb et al., pp. 143–168), and the ingeniously eponymous new generic name *Trinashotrema* for "Nash's pore lichens" in the *Stictidaceae* for some taxa previously placed in *Conotrema* and *Ocellularia* (Lücking et al., pp.187–210). Amongst the other papers, I found the resurvey of the area around the Palmerton zinc smelter in Pennsylvania of particular interest. The effects of this smelter on lichens were the topic of Tom's PhD dissertation of 1971; it ceased functioning in 1980, and along Tom's transects, lichen cover on bark and wood was found to have increased substantially, from 0.6 to 1.4 m^2 (229%), and on rocks and the ground from 7.6 to 22 m^2 (296%) (Howe & Lendemer, pp. 127–142).

Also included are a most readable account of Tom's career and achievements including several photographs of him in action teaching in the field (Bates & Bungartz, pp. v–xvi), and a meticulously prepared 14-page list of his published works (pp. 409–422). It was, however, somewhat depressing to learn that the 100,000+ specimen lichen collection Tom had built up at ASU, which includes around 50,000 he made, was no longer accessible except by visits, as no curator had been recruited.

The book has been edited and prepared to the high standards customary in the series, and especially welcome was the inclusion of coloured plates at the end, which illustrate many of the contributions. Volumes recognizing the

contributions of outstanding lichenologists have become one of the mainstays of BIBLIOTHECA LICHENOLOGICA, but the volumes are expensive for personal purchase and the generally specialized papers included consequently tend to be passed by lichenologists as a whole. Perhaps increased availability of the individual articles could be achieved by making them available free or charge on the Internet?

Tom's achievements include combining field studies with often pioneering laboratory experimentation, and later also novel bioinformatic approaches, but it is the superlative LICHEN FLORA OF THE SONORAN DESERT REGION (3 vols, 2002–2007) that will constitute his most important legacy to lichenology. That he managed to cajole so many lichenologists around the world to contribute to that work, and on a finite time-scale and in a common format, will never cease to amaze me. Another legacy is his students. Tom himself seems to have been greatly influenced by the late William ("Bill") L. Culberson, whose class at Duke University he took during his formative years. Sadly, with Tom's departure from ASU, another institution where future lichenologists might be spawned and nurtured has to be deleted from the list. However, there is no doubt that he achieved more than could reasonably have been expected of him, and he deserves a well-earned and enjoyable "retirement."

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Suomen Jäkäläopas. By S. Stenroos, T. Ahti, K. Lohtander & L. Myllys (eds). 2011. NORRLINIA no. 21. Kasvimuseo, Luonnontieteellinen keskusmuseo, Helsinki, Finland. http://www.luomus.fi. Pp. 534, illustr., col. plates. ISBN 978-952-10-6804-1. Price: 45 €

The standard of colour lichen macrophotographs increases by leaps and bounds, partly as technology advances, but also with the skills of the photographers. Now, the modern classics for coloured photographs of macrolichens of Wirth (1995) and Brodo et al. (2001) must be supplemented by this superbly illustrated account of those occurring in Finland. It is now a 'must have' for the shelves of all lichenologists, even though the text is in Finnish. Indeed, so superbly produced is this book that it was awarded the 2011 Tieto-Finlandia prize of 30 000 €, Finland's most significant non-fiction award.

In all, 481 species and infraspecific taxa are treated, including all the macrolichens and also a few common crustose species known in the country. The alphabetical systematic treatment is prefaced by a wide-ranging account of lichenology in Finland, from the historical, through the ecological and commercial exploitation aspects. Apart from the illustrations, the accounts

include short descriptions, information on synonyms, spot-tests, ecology, and distribution (with maps indicating provinces where the species are known). Keys are also provided for the larger genera.

This lavish production has been very much a team effort by Finnish lichenologists as a whole, and the authors of particular genera are appropriately credited (p. 52). It will be of particular international value for the comprehensive treatments of genera such as *Bryoria*, *Cladonia*, and *Peltigera*, for which colour images of many species appear in print here for the first time.

Non-Finnish speakers are aided by a glossary of Finnish/English terms (p. 516), but the photographs with scientific names largely speak for themselves. Even though the primary target for this work was clearly to produce an authoritative and comprehensive stand-alone for Finnish ecologists and naturalists, it might have been valuable also to include references to other publications and websites. I did not even catch a reference to the multi-volume and comprehensive Nordic Lichen Flora (1999 ff.), with which some of the editors are much involved, but may have missed it in the Finnish text.

I suspect that Teuvo ('Ted') Ahti was very much a driver of this work, and he, as well as his co-editors and contributors, should be proud of this extraordinary achievement. Such works are the key to catching the imagination of potential lichenologists of the future, as well as facilitating precise identifications by non-specialists.

Brodo IM, Sharnoff SD, Sharnoff S. 2001 Lichens of North America. New Haven: Yale University Press.

Wirth V. 1995. Die Flechten Baden-Württembergs. 2nd edn. 2 vols. Stuttgart: Eugen Ulmer.

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Basidiomycetes

Funga Nordica. Agaricoid, boletoid, clavarioid, cyphelloid and gastroid taxa. 2nd edition. By H. Knudsen & J. Vesterholt (eds). 2012. Nordsvamp, c/o Botanical Museum, Gothersgade 130, 1123 Copenhagen, Denmark. ISBN 978-97-983961-3-0. Pp 1083. Price 119 €

This is the second edition of the Funga Nordica that came out in 2008. The new version has been enriched with many crust-forming fungi, gasteroid taxa, and a number of taxa with hymenophores other than gilled or pored. The inside of the back cover indicates that in practice for some orders all taxa are treated while only a scattering of taxa are covered for others. Two types of keys, one

based on hymenophore type and one based on phylogeny, are presented. So, although some crust forming species are included, the majority of the species not cited should be keyed out with specialized literature. As some genus and family concepts have been updated to accommodate recent findings, this is still the only book to really incorporate results from the molecular-phylogenetic studies that revolutionized our perception of mushroom taxonomy so much in the last decade.

A total of 56 families, 278 genera, and over 3000 species are included. Those who fondly remember the CD with the colour photos of the first edition will be disappointed to learn that they are not included in the second edition.

Family and generic concepts in general follow Index Fungorum and Mycobank; but I was surprised to see that *Cystoderma* and allies (in their own family in the first edition) and the Bird's nest fungi now are included in the family *Agaricaceae*, as there is no good evidence for such a placement.

I wish that Jan Vesterholt, editor for the first edition, had lived to see this second edition.

A general review of the first edition can be found in MYCOTAXON 110: 521 (2009), and I heartily agree with that reviewer that this book should be on every mycologist's work surface.

Tricholomas of North America. A mushroom field guide. By A.E. Bessette, A.R. Bessette, W.C. Roody, & S.A. Trudell. 2012. University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, <www.utexaspress.com>. Pp 208, numerous colour plates. ISBN 978-0-292-74233-8. Price $29.95

The genus *Tricholoma* harbours many species that are difficult to identify. Furthermore, the literature on these species is scattered, and in many cases good colour photographs are lacking, which is especially difficult in a group where the microscopical characters are few and not very informative. The field guide by Bessette et al. of North American tricholomas fills the gap between scientific literature and the normal region-focused guidebook by presenting good quality descriptions and colour photographs of around 75 *Tricholoma* species. Most are illustrated, and in many cases multiple photos are given, to show the range of colours and shapes.

The book starts out with an introduction to the genus, its nomenclatural history and how to distinguish its taxa from other genera, an overview of the important characters, and a key to the species. The key is divided up into eight separate dichotomous (or in some cases trichotomous) keys: for eastern and for western species, and for white, grey, brown, or yellow species, with considerable overlap between the keys. At the end of the book, a list of additional as-yet unnamed species are presented, plus a list of species names that can be found

in the literature but are hard to interpret or otherwise insufficiently known, a glossary, a list of references, and indices can be found.

In the introduction the authors stress that much work still has to be done; for instance a rigorous comparison of molecular characters of American and European taxa is very much needed. This is indeed required, as I get the impression that European names are misapplied in some cases: I would not, for instance, recognize *Tricholoma sulphureum* from the photos in this book. Many species from the literature are insufficiently known, and which names to apply to the recognized taxa is also an unsolved problem. But, the authors also express the hope that with this book, renewed interest in the genus will be kindled in many mushroom lovers. The colour photos certainly invite readers to pay more attention to this important group of mushrooms.

As in other such guidebooks, the sources of the information are not given — whether descriptions are based on the literature or on personal observations, whether there are herbarium vouchers for the photographs, none of these issues are touched on.

But in summing up this book, I end on a very positive note: the lay-out of the book is pleasant, the book is very affordable, the quality of the photos is in general high, and at last it gives insight in the North American *Tricholoma* flora.

Gli Igrofori. Atlante pratico-monografico per la determinazione delle *Hygrophoraceae* Roze ex Lotsy. By R. Galli. 2012. dalla Natura, Franca Marmonti s.a.s., Via Andrea Costa 2, 20136 Milan, Italy. <franam2@alice.it>. Pp 208, many col. pl. Price 56 €.

Waxcap mushrooms of eastern North America. By A.E. Bessette, W.C. Roody, W.E. Sturgeon, and A.R. Bessette. 2012. Syracuse University Press, 621 Skytop Road, Suite 110, Syracuse, NY 13244-5290, <supress@syr.edu> <www.syracuseuniversitypress.syr.edu>. Pp 192, 167 colour plates. ISBN 978-0-8156-3268-9. Price $ 95

The *Hygrophoraceae* are basking in a lot of attention, book-wise. Two new books were published this year, one treating the eastern North American species and the other the Italian species of *Hygrophorus* and *Hygrocybe* s.l. Both use the same genus concepts, with a 'lumping' approach to *Hygrocybe,* which includes *Cuphophyllus*, *Humidicutis*, and *Gliophorus*, and in the American book, even species of *Camarophyllopsis*.

The North American book starts with a short introduction to the groups, followed by the species descriptions, all photos grouped by colour and look-alikes, with a glossary, resources, and indices at the end. A key to the species is not given. In many cases several photos per species are provided, and many classic eastern species are depicted here for the first time. Although photo

credits are given, there is no information about the locality where the photos were made nor where the descriptions came from. Some new combinations for *Hygrocybe* species originally described in the genus *Hygrophorus* are invalidly proposed without references to the basionym. The photos are of reasonable quality, though I have to admit that the *Hygrocybe* photos in Boertmann's book (2010) are much more pleasing and informative. The high price of this rather slim volume is a serious drawback.

The Italian book starts out with a lavishly illustrated 35-page introduction, which pays ample attention to macroscopical, microscopical, ecological, and culinary characters and aspects of the family. Keys to genera, sections, and species are presented in both Italian and English. Species descriptions are in Italian only. Each species gets at least one page, often several pages with big photographs and colour illustrations, and a line drawing of the main microscopical characters. The specmens are, as in the American book, photographed in the field. Some photos are a bit vague, but most are of good quality, showing the variation and the characters of the species.

Both books rely heavily on morphological species concepts. I would love to see a follow up in which molecular and morphological data are combined, giving us real insight into the world of these colourful intriguing species. A quick look in GenBank is enough to realize that ITS sequences with the same taxon name attached are not similar, even within Europe. Let us hope that these books will stimulate further research.

Boertmann D. 2010. The genus *Hygrocybe*. 2nd ed. Fungi of northern Europe vol. 1. Svampetryk. 200 p.

General

Cytology and plectology of the hymenomycetes. By H. Clémençon, with the assistance of V. Emmett and E.E. Emmett, 2012. 2nd revised edition. J. Cramer in der Gebr. Borntraeger Verlagsbuchhandlung, Johannesstr. 3A, 70176 Stuttgart, Germany <mail@borntraeger-cramer.de>. Figs 636. ISBN 978-3-443-50037-5. Price 98 €

If I could choose only one mycological book to take with me on a 2-week stay on an uninhabited island, this would be it. It is chock-full of information, interesting facts, and historic tit-bits, and it is heartily recommended for everybody who is interested in the phylogeny, development, and characters of mushroom forming basidiomycetes.

The first edition, published in 2004, has been expanded with new findings published from 2003 to 2011; names have been updated, and some colour plates have been added. This version is 32 pages thicker than the first one.

With the often-unexpected outcomes from phylogenetic studies, knowledge of morphological data is more than ever in demand, and everyone should have access to this book.

For the rest I refer the reader to the equally enthusiastic review by David Hawksworth of the first edition, in Mycotaxon 90: 474–476 (2004).

Book Announcements

Atlas of soil *Ascomycetes*. By J. Guarro, J. Gene, A.M. Stchigel and M.J. Figueras. 2012. CBS Biodiversity Series 10. CBS-KNAW Fungal Biodiversity Centre, P.O. Box 85176, 3508 AD Utrecht, The Netherlands. <info@cbs.knaw.nl>. Pp. 486, 322 figs. Price 70 €

Biodiversity of *Heterobasidiomycetes* and non-gilled hymenomycetes (former Aphyllophorales) of Israel. Biodiversity of Cyanoprocaryotes, algae and fungi of Israel. By D. Ţura, I.V. Zmitrovich, S.P. Wasser, W.A. Spirin & E. Nevo; edited by S. Wasser, 2011. A.R.A. Gantner Verlag K.-G (distributed by Koeltz Scientific Book <www.koeltz.com>. ISBN 978-3-906166-99-5. Pp 566. Price 93.00 €.

***Entolomataceae* in Tasmania.** By M.E. Noordeloos and G.M. Gates, 2012. Fungal Diversity Research Series 22. 212 figs (106 in colour), xvi and 354 p. ISBN 978-9400746787 Price $169.99

International Code of Nomenclature for algae, fungi, and plants (Melbourne Code) adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011. By J. McNeill, F.R. Barrie, W.R. Buck, V. Demoulin, W. Greuter, D.L. Hawksworth, P.S. Herendeen, S. Knapp, K. Marhold, J. Prado, W.F. Prud'homme van Reine, G.F. Smith, J.H. Wiersema and N.J. Turland, 2012. Regnum vegetabile 154. Pp xxx, 240. ISBN 978-3-87429-425-6. Price 59 €

Smut fungi of the world. By K. Vánky. 2012. American Phytopathological Society Press, 3340 Pilot Knob Road St. Paul, MN 55121, U.S.A. <aps@scisoc.org>. Pp xvii, 1458, 650 line drawings; 2800 micrographs. ISBN 978-0-89054-398-6. Price $499

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MYCOTAXON

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Regional annotated mycobiotas new to the Mycotaxon website

Mycotaxon is pleased to announce four new species distribution lists to our 'web-list' page covering *Tricholomataceae* and *Polyporaceae* in Argentina (by Niveiro & Albertó); macrofungal diversity in Colombia (by Vasco-Palacios & Franco-Molano); smut fungi in Croatia (by Ivić & al.); and *Boletales* in Pakistan (by Sarwar & Khalid). This brings to 98 the number of free access mycobiotas now available on the Mycotaxon website:

http://www.mycotaxon.com/resources/weblists.html

South America

Argentina

N. Niveiro & E. Albertó. Checklist of the Argentine *Agaricales* 4. *Tricholomataceae* and *Polyporaceae*. 97 pp.

Abstract — A species checklist of 86 genera and 709 species belonging to the families *Tricholomataceae* and *Polyporaceae* occurring in Argentina, and including all the species previously published up to year 2011 is presented.

Colombia

Aída Marcela Vasco-Palacios &Ana Esperanza Franco-Molano.. Diversity of Colombian macrofungi (*Ascomycota - Basidiomycota*). 48 pp.

Abstract — A checklist of the species of Colombian macrofungi cited in the literature is presented. A total of 130 published articles were reviewed. These reported 1239 species of macrofungi belonging to 32 orders and 105 families of *Ascomycota* and *Basidiomycota*. Lichens were not included.

Europe

Croatia

Dario Ivić, Zdravka Sever, Christian Scheuer & Matthias Lutz. A preliminary checklist of smut fungi of Croatia. 10 p.

Abstract — A list of smut fungi (*Ustilaginomycotina* p.p. and *Pucciniomycotina*: *Microbotryales*) recorded in Croatia from 1897 to 2011 is given. In total, 41 smut species belonging to 13 genera found on 41 host plant species have been recorded in Croatia. Additionally, four smut specimens were reported that could not be determined to species level. Five species are newly reported for Croatia: *Macalpinomyces neglectus*, *Sphacelotheca hydropiperis*, *Urocystis poae*, *Ustilago striiformis,* and *Ustilago trichophora*.

Asia

Pakistan

Samina Sarwar & A.N. Khalid. A preliminary checklist of the *Boletales* in Pakistan. 12 p.

Abstract — This is the first attempt to make a comprehensive checklist of the boletes that exist in Pakistan. The families are arranged in alphabetical order (*Boletaceae*, *Diplocystidiaceae*, *Gomphidiaceae*, *Paxillaceae*, *Sclerodermataceae*, *Suillaceae*, *Tapinellaceae*), with the genera arranged alphabetically within each family. Each species is given with its distribution. A total of 54 taxa are presented.

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bad taxonomy

can KILL